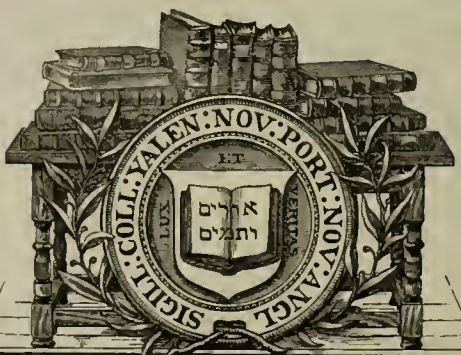
Summer Complaint and Infant Feeding.

CHRISTOPHER.



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SUMMER COMPLAINT

AND

INFANT FEEDING.

BY

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PREFACE.

Chapter I. is an essay which appeared in the *New York Medical Journal*, November 9, 1889. The subject of which it treats, "SUPERDIGESTION," is closely related to the chemical processes occurring in the intestines in summer complaint, if indeed it does not entirely comprehend them. It is included here to assist in explaining these processes. The last paragraph of this chapter was not in the original essay.

Chapters II., III., and IV., are lectures delivered in the Fourth Special Course of the Chicago Policlinic during the spring of 1892. They were published in the *Journal of the American Medical Association* of April 30, May 7 and May 21, 1892. Having been prepared for publication from a stenographer's report they still retain the didactic style.

Chapter V. was read before the Section of Diseases of Children, of the American Medical Association, at Detroit, June 7, 1892. It is to appear in the August number of the *Archives of Pediatrics*. Acknowledgment is hereby made to the publishers of these several journals for permission to reprint.

This arrangement necessarily involves some repetition.

W. S. C.

408 Center Street,
July 25, 1892.

CONTENTS.

CHAPTER I.

INTESTINAL SUPERDIGESTION.

There is a very prevalent misconception of the conditions of the so-called intestinal fermentation. The idea seems to be very general that fermentation is opposed to digestion—that is to say, that a food may either be digested or undergo a fermentation, but cannot be both digested and fermented. Fermentation, broadly speaking, includes digestion, which is the normal or physiological fermentation which food undergoes previous to its absorption. But the fermentation referred to above is not used in this sense, but in the narrower one of pathological fermentation. In studying this subject it must, however, be borne in mind that the digestive processes are fermentations; that they are induced by soluble or unorganized ferments,* and that the pathological fermentations are maintained by organized ferments—different microörganisms.

Many organized ferments require that the substances which they are to act upon shall first have been modified by some other ferment, either soluble or organized, before they can exert their peculiar action. For instance, the yeast-plant cannot ferment cane-sugar directly, while it can induce the alcoholic

* Fermentations by microörganisms, producing the same products as the soluble digestive ferments, have no bearing on the present discussion, and are not here referred to.

fermentation in the glucoses. In the fermentation of cane-sugar by the yeast-plant, the sugar is first inverted—that is, transformed into dextrose and levulose, two glucoses—before the alcoholic fermentation occurs. The inverting of the cane-sugar is accomplished by a soluble ferment which accompanies and is probably produced by the yeast-plant itself. At all events, its action precedes the alcoholic fermentation induced by the plant. Similarly, according to Schützenberger,* the butyric fermentation is usually, perhaps invariably, preceded by the lactic fermentation. It seems that certain changes in the albuminous constituents of milk are produced by the lactic ferment, which fit these albumins to nourish the butyric ferment, and thus enable it to grow.

Another illustration of this peculiarity of ferments is found in the different organisms which prevail at different times during the progress of a putrefaction.

In the gastric digestion of proteids the process ends with the formation of peptones, but in pancreatic (tryptic) digestion of proteids the decomposition of the albuminoid molecule is more profound, and we find in addition to the peptones, leucin, tyrosin, hypoxanthin, aspartic acid, and glycocol. With these products the fermenting action of the pancreatic juice probably ends, but this action has paved the way for the growth of microörganisms, which flourish among the products of the tryptic digestion, and, as the result of their action upon these products, there are produced such bodies as indol, scatol, phenol, fatty acids, ammonia, hydrogen, sulphuretted hydrogen, carbonic acid, and ptomaines (Ewald, Charles, and Landois).

* On Fermentation. New York, 1887.

In making artificial digestion experiments, the readiness with which putrefaction sets up in the pancreatic digestion of proteids is very striking, particularly when compared with gastric processes.

Now, since this putrefactive process is impressed upon the products of the digestion, and is not a change produced directly in the original food-stuff itself, but rather a continuation of the decomposition processes set up in the albumin molecule by the digestive ferment proper, it seems to me that the term superdigestion fitly characterizes it. Certainly the term indigestion is eminently improper and misleading.

In general terms, superdigestion may be defined as pathological fermentation of the products of normal digestion. It is always induced by micro-organisms, and varies according to the food.

We may therefore have—

a. Superdigestion of proteids.

b. Superdigestion of fats.

c. Superdigestion of carbohydrates.

a. Superdigestion of Proteids.—Proteids are digested both by the gastric and by the pancreatic juices, but superdigestion of the products of gastric digestion is infrequent, at least in the stomach, while further change of the pancreatic products is exceedingly common. This difference is probably due less to any doubtful antiseptic action on the part of the gastric juice than to the difference in extent of the digestion or decomposition of the albumin molecule produced by the two juices. We may dismiss stomachic superdigestion of proteids and confine ourselves to that which occurs in the intestine. The most interesting of the intestinal decomposition products of proteids, for our present purpose, are the

fatty acids, the ptomaines, and the gases, which latter comprise carbonic-acid gas, ammonia, nitrogen, hydrogen, marsh gas, and sulphuretted hydrogen. Certain of the gases unite with each other and form non-volatile salts, and others are formed in relatively small amount, so that in this form of superdigestion flatulence is not a marked symptom, excepting in certain cases of diarrhœa-producing putrefactions, and then the origin of the gas is by no means certain.

The fatty acids thus formed do not accumulate in sufficient quantity to produce a strong acid reaction in the intestine, and probably, therefore do not cause pain. In their further decomposition the fatty acids give rise to gases. The ptomaines are the important products of the superdigestion of proteids. These bodies are alkaloids, and, like the vegetable alkaloids, produce their effects through the agency of the central nervous system. They are partly excreted with the fæces, and in part absorbed. After absorption they have another gauntlet to run in the liver, one of whose functions, as Schiff has shown, is to destroy these bodies. Consequently, it is only when they are formed in excess, or the liver fails to destroy them, that they gain entrance to the general circulation and produce general effects. The nature of the symptoms produced by the ptomaines varies according to the physiological properties of the ptomaine produced. A not uncommon group of symptoms produced in this way comprises constipation, headache, drowsiness, and listlessness, or even a marked depression—the so-called biliousness. Here there seems to be at work, a ptomaine or ptomaines possessing the properties of morphine and curare.

It is exceedingly common to find, particularly in young children, a sudden high fever, often preceded by a convulsion, which can be attributed to nothing else than an intestinal putrefaction, and which disappears completely and finally when a brisk cathartic has removed the putrid contents of the bowel. In infants, conditions closely resembling ytphoid fever, but only lasting two or three days, may be attributed to a similar cause.

Certain eruptions on the skin betoken poisoning from the intestinal canal, particularly erythematous eruptions.

I have elsewhere ("Medical News," March 3, 1888) expressed my belief in superdigestion being the important factor in the ætiology of summer complaint.

Generally speaking, the superdigestion of proteids plays a more important rôle in infants and young children than it does in adults.

The treatment of the condition follows from its pathology, and consists, first, in the use of a cathartic—preferably calomel—to remove the putrefying masses from the intestine; second, in the administration of an intestinal antiseptic, of which naphthaline is my own favorite, but good ones are found in salol, bismuth salicylate, quinine tannate, and small doses of calomel; and, finally, in withholding all albuminous food until the abnormal process in the intestine has entirely ceased. Of these three steps, the most important is the one relating to diet. By it alone many cases can be controlled. The least important is the use of intestinal antiseptics, and much disappointment arises from depending upon this means alone.

b. Superdigestion of Fats.—The great bulk of the

fats ingested are normally rendered absorbable by emulsification. Normally a small proportion of the fats and abnormally a larger one undergoes decomposition into glycerin and the corresponding fatty acid. As already indicated, the fatty acids themselves break up under the influence of certain organized ferments, yielding gases—to-wit, carbonic-acid gas, hydrogen, and marsh gas. It is somewhat doubtful whether even the small amount of fats which is decomposed into glycerin and fatty acids, under apparently normal conditions, is a process essential to the digestion of these substances, and when a large proportion of the fats ingested undergoes this decomposition, either before or after emulsification has occurred, it must be regarded as a superdigestion. The subsequent gaseous decomposition of the fatty acids is unquestionably a superdigestion. Owing to the comparatively small amount of fat taken as a food, the gases resulting from its fermentation do not of themselves constitute an important clinical factor; but when they go to increase the flatulence produced by other decompositions they must be taken into consideration.

For reasons which will appear further on, the gaseous fermentation of fats occurs most frequently in connection with the gaseous fermentation of carbohydrates.

c. Superdigestion of Carbohydrates.—The carbohydrates used as foods are starch, cane-sugar, maltose, lactose, and glucose. Cellulose is a carbohydrate which is found in connection with other carbohydrates in many substances used as foods. It has a pathological but not a physiological importance. Starch is digested both by the saliva and by the

amylolytic ferment of the pancreatic juice. The action of the saliva occurs in the mouth, and continues, to some extent at least, in the stomach, for the experiments of Chittenden and Griswold show that the presence of 0·005 per cent. of hydrochloric acid increases the diastatic action of the saliva, while a stronger acid diminishes it, 0·1 to 0·4 per cent. being sufficient to completely stop the action of the saliva. Nevertheless, even in the presence of the comparatively stronger acid, peptones which are found in the stomach in the digestion of proteids are capable of stimulating the saliva to increased action (Charles, "Physiological Chemistry"). This fact plays an important rôle in the treatment of the superdigestion of carbohydrates in the intestines. The digestion of starch by the saliva, by the pancreatic juice, and by diastase may be represented by the following equations:

$$\underset{\text{Starch.}}{3(C_6H_{10}O_5)} + H_2O = \underset{\text{Grape-sugar.}}{C_6H_{12}O_6} + \underset{\text{Dextrin.}}{2(C_6H_{10}O_5)}$$

$$\underset{\text{Dextrin.}}{2(C_6H_{10}O_5)} + 2H_2O = \underset{\text{Grape-sugar or Glucose.}}{2(C_6H_{12}O_6)}$$

According to Mering, the action of saliva on starch produces dextrin and maltose, $C_{12}H_{22}O_{11}$. But whether grape-sugar or maltose is produced by this action is immaterial to our present purpose, as both may subsequently undergo the same pathological fermentations.

Cane-sugar and lactose, both of which are saccharoses and have the same formula, are digested by being inverted, that is, by being broken up into dextrose and levulose, both of which are glucoses. The action occurs in the intestine and may be represented as follows:

$$\underset{\text{Cane-sugar.}}{C_{12}H_{22}O_{11}} + H_2O = \underset{\text{Dextrose.}}{C_6H_{12}O_6} + \underset{\text{Levulose.}}{C_6H_{12}O_6}.$$

It will thus be seen that all the carbohydrates in their normal digestion are converted into glucoses.

It now remains to be seen what abnormal fermentations the glucoses may undergo in the small intestine. In the first place, glucose, under the influence of one or other of the many lactic ferments, is transformed into lactic acid, which substance, when present in the intestine in large quantity, seems to be a cause of pain.

The reaction is as follows:

$$\underset{\text{Glucose.}}{C_6H_{12}O_6} = 2(\underset{\text{Lactic acid.}}{C_3H_6O_3}).$$

Lactose may break up directly into lactic acid, thus:

$$\underset{\text{Lactose.}}{C_{12}H_{22}O_{11}} + H_2O = 4(\underset{\text{Lactic acid.}}{C_3H_6O_3}).$$

The lactic acid is then acted upon by the butyric ferment, if it be present, with the following result:

$$\underset{\text{Lactic acid.}}{2C_3H_6O_3} = \underset{\text{Butyric acid.}}{C_4H_8O_2} + \underset{\text{Carbonic acid gas.}}{2CO_2} + \underset{\text{Water.}}{2H_2O}$$

The alcoholic fermentation under the influence of yeast may also occur:

$$\underset{\text{Glucose.}}{C_6H_{12}O_6} = \underset{\text{Alcohol.}}{2C_2H_6O} + \underset{\text{Carbonic-acid gas.}}{2CO_2}$$

The alcohol may then undergo acetous fermentation, thus:

$$\underset{\text{Alcohol.}}{C_2H_6O} + O = \underset{\text{Aldehyde.}}{C_2H_4O} + H_2O$$

$$\underset{\text{Aldehyde.}}{C_2H_4O} + O = \underset{\text{Acetic acid.}}{C_2H_4O_2}$$

The following fermentations of the lime salts of fatty acids, which are induced by microörganisms, should also be noted:

$$(CHO_2)_2Ca + H_2O = CaCO_3 + CO_2 + 2H_2O$$

Calcium formate. — Calcium carbonate. — Carbonic acid gas. — Water.

$$(C_2H_3O_2)_2Ca + H_2O = CaCO_3 + CO_2 + 2CH_4$$

Calcium acetate. — Calcium carbonate. — Carbonic acid gas. — Marsh gas.

Cellulose, which has been referred to as a carbohydrate ingested with certain food-stuffs, undergoes the following gaseous fermentation under the influence of some microörganism not as yet isolated:

$$C_6H_{10}O_5 + H_2O = 3CO_2 + 3CH_4$$

Cellulose. — Carbonic acid gas. — Marsh gas.

In summing up, we find that glucose may undergo the alcoholic fermentation with liberation of carbonic-acid gas, or it may be converted into one of several fatty acids, and these, breaking up in their turn, give rise to carbonic-acid gas and either hydrogen or marsh gas. Bringing together the first and last of this long string of processes, we may say that the carbohydrate foods, in superdigestion, produce large quantities of gas in the intestine.

The clinical features of the superdigestion of carbohydrates are very well exhibited by the following cases:

CASE 1.—J. L., aged thirty-three, had been sick about three weeks with severe pain, which could ordinarily be referred to the abdomen, but at times seemed to spread over a much larger region, so that it was difficult to say where there was not pain. Distress had been constant, but at times during the day was more marked than at others. These times could not be fixed

with any reference to meals, but paroxysms of marked severity were very certain to occur at night. From this cause much sleep had been lost. During ten days the gentleman had been able to present himself at his office but two or three times, and was then so weak as to be utterly unable to attend to business. There had been no fever throughout the trouble. His physical appearance was one of emaciation, with features pinched and drawn. The emaciation was so marked as to lead to the suspicion of tuberculosis, but an examination of the lungs revealed them to be perfectly healthy. The abdomen was considerably distended and tympanitic, bowels slightly costive. He had been advised to take a "light" diet, under which ambiguous term was included toast and tea, rice, blanc mange, and other farinaceous foods. Carbohydrate superdigestion being diagnosticated, he was given a saline laxative, and his diet limited to albumins—viz., meat, fish, and white of egg, while starches, fats, and sugars were strictly prohibited. Milk, as it contained sugar, was among the foods forbidden. After being deprived of carbohydrates for only two meals, his pain disappeared and did not recur. He was able to sleep the first night, and reported the next day as feeling better than he had for three weeks. This freedom from pain continued throughout the case. Here it was perfectly evident that the withholding of carbohydrates kept out of the intestine those substances which could maintain the abnormal fermentations there going on. The problem then was simply one of withholding this kind of food until the offending microörganisms had been removed from the intestine, either by the aid of remedies or by their own death from starvation. At the end of a week a small piece of bread was allowed, but the return of gas and a slight colic, a few hours after its ingestion, showed that the intestine was not yet ready to receive food of this character. A strictly albuminous diet was then observed for another week, when an attempt showed that the carbohydrates could be borne. During the period of dieting, intestinal antiseptics were administered, but whether any advantage was gained from their use is very doubtful.

A strictly albuminous diet is quite difficult to maintain, the craving for bread being so great that nothing short of the tortures of this form of dyspepsia

will keep the patient's courage up to the required pitch. I have frequently ameliorated this trouble by allowing the patient, toward the end of his period of dieting, a small piece of bread with each meal, and immediately after the meal administering a diastatic ferment. The choice of a diastase is by no means unimportant. The pancreatic ferments should be avoided, lest by their action upon the proteids they pave the way for more trouble. An active malt diastase is to be preferred. By this means we are enabled to digest starch in the stomach, from which organ it is absorbed, so that little or none of it can reach the seat of the trouble in the intestine. If the patient take more bread than can be handled in this way, he is reminded of his indiscretion some two or three hours after his meal. Instead of using diastase, I have had patients swallow saliva, promoting its secretion by the use of chewing gum, but the practice has not been followed by any beneficial results.

CASE II.—M. T. had been troubled more or less continuously for two years with constipation, flatulence, and abdominal pain. The pain appeared usually a few hours after meals, and of late the paroxysms of flatulent colic had become frequent and severe. He was very anæmic, had an anxious expression of countenance, but was not so emaciated as might have been expected from the long duration and severity of his trouble. The principal symptom for which he applied for relief was constipation, and he said that he had not had a stool for two weeks, although he had been taking cathartics continuously. Physical examination revealed an abdomen enormously distended and tympanitic, but not tender. There was no fever and there were no gastric symptoms. He was given ten grains of calomel to take at bedtime, and to be followed by Epsom salts in the morning. He reported the next evening stating he had taken the calomel and three doses of salts, but had had no movement from the bowel. Resort was

then had to croton-oil, with the effect of producing a copious discharge of gas and liquid and solid fæces. The stools were exceedingly offensive in odor, indicating that a superdigestion of proteid material had occurred as well as superdigestion of the carbohydrates. The carbohydrate trouble being the more pressing, attention was directed to it, and the patient put on a strictly albuminous diet. Owing to the long continuance of the gaseous fermentation, the bowels had become enormously dilated, with corresponding muscular atony, producing a complication peculiarly unfortunate, because of the difficulty of keeping the intestine cleared of the fermenting masses. This difficulty was overcome, however, with suitable cathartics. The necessary period of abstinence from carbohydrate food was in this case unusually protracted, lasting some five weeks, for which reason the plan of digesting bread in the stomach was peculiarly useful. Notwithstanding the greatest care in diet, he had during this period one severe attack of flatulent colic, and at another time, for several days he required washing of the stomach, but practically he was free from pain throughout the whole period. Some two or three weeks after he was enabled to return to a general diet, and before he had regained completely his strength, he developed an hysterical condition, which baffled handling. The bowel trouble had, however, been entirely overcome.

The condition often occurs in an acute form, and yields readily to proper dietetic treatment. I have seen a good diastase, administered so as to digest the starches in the stomach, quickly arrest a very severe case, even when the starchy foods were only limited and not absolutely prohibited. In a mild form, superdigestion of carbohydrates is a very common affection and yields readily to treatment, a cathartic alone being often sufficient to break up an attack.

All forms of superdigestion are apt to recur.

As a result of long-continued carbohydrate superdigestion, a form of malnutrition may appear. This

malnutrition is characterized principally by lack of nervous stability, and hysterical explosions are common. Patients subject to this disorder frequently learn the food which disagrees with them, and consequently use it sparingly. This sparing use of the food is not sufficient to supply the needs of the organism for the particular food in question, but is sufficient to constantly maintain the abnormal fermentations and prevent a return to a proper amount of carbohydrates. Moreover, the excessive formation of vegetable acids in the intestine results in the excretion of a large amount of alkaline carbonates in the urine. Doubtless this alkaline drain is partly responsible for the resulting malnutrition.

CHAPTER II.

CLASSIFICATION OF DIARRHŒAS—ETIOLOGY AND PATHOLOGY OF SUMMER COMPLAINT.

The diarrhœal diseases constitute a very large percentage of the diseases of infancy, and yet, in the majority of the text-books, they are discussed in the routine manner of years ago.

The recent advances in bacteriology and chemistry have not failed to throw much light upon the etiology and pathology of these diseases, and it is my desire in this course to consider them from a modern standpoint.

It is customary to speak of summer diarrhœa. I avoid the term diarrhœa, and use instead the term summer complaint. Summer complaint includes not only the diarrhœal forms of these diseases, but those forms characterized by constipation, and I hope to show you that many cases which are truly cases of summer complaint, with all the symptoms and the unfortunate results of summer complaint, are characterized from beginning to end by the symptom, constipation. The term summer complaint, therefore, is in this sense comprehensive enough to cover the ground.

Every diarrhœa which a baby may have is not a case of summer complaint, any more than every diarrhœa which an adult has is a case of cholera morbus. It becomes desirable for me to give you such a classification of diarrhœal diseases as will give you a clear idea of where I stand with reference to summer complaint, what I mean by it, and to what conditions my remarks may be addressed as regards the pathology and treatment of this particular disease.

The most scientific classification of diseases is based upon their etiology, and I beg to offer you a classification of the diarrhœal diseases framed on a sort of etiological basis. This classification is not complete. None of the classifications which have been given of diarrhœal diseases, particularly those of infants, have been satisfactory. Diarrhœal diseases are commonly divided into enteritis, gastro-enteritis, and colitis, upon the supposition that certain anatomical portions of the bowel are involved in the different cases. I hope to be able to show that there is no essential difference between colitis and enteritis, and that the symptoms by which we attempt to separate the one from the other are not due to a difference in the anatomical change of the bowel itself, and that therefore a classification upon an assumed pathology is incorrect, because the pathological conditions cannot be made recognizable with the clinical manifestations.

The classification which I have to offer is the following:

Diarrhœa produced by:

I. Causes arising in tissue change. Nutritional disturbances.
   1. Rickets.
   2. Scurvy.
   3. Tuberculosis.
   4. Wasting diseases generally.
   5. Nervous diarrhœa.
   6. Uræmia.

II. Poisons developed in the blood.
   1. Septicæmia.
   2. Specific infectious diseases.
      a. Typhoid fever.
      b. Tuberculosis (?).
      c. Malaria.
      d. Amœbic dysentery (?).
      e. Influenza.

III. Poisons developed in or on the intestinal walls.
   1. Diphtheria of the bowel.
   2. Amœbic dysentery.
   3. Thrush.
   4. Chronic ulceration of the bowels.

IV. Poisons developed in the intestinal contents.
   1. Asiatic cholera.
   2. Summer complaint (infants').
   3. Cholera morbus (adults and older children).
   4. Typhoid fever (?).
   5. Amœbic dysentery.

Many of the diarrhœas met with in rickets and scurvy can be explained in no other way than by the assumption that they are produced directly by the nutritional changes themselves. A germicidal theory is untenable, and nothing within the bowels themselves can satisfactorily account for the phenomena. No doubt, in many of the wasting diseases, diarrhœa is dependent upon similar causes. In every specific disease characterized by diarrhœa, the cause of that diarrhœa is a poison developed in the blood. The diarrhœa of typhoid fever is unquestionably produced, not by the ulcers which form in the bowels, but by the same poisons which produce the elevation of temperature; by the same poisons which produce irregularity of the heart's action; by the same poisons which produce bronchitis; by the same

poisons which cause the eruption upon the body. It is entirely gratuitous to assume that because there is a lesion in the bowel, that that anatomical lesion is the cause of the diarrhœa which is present. Under the head of specific diseases which produce diarrhœa we have typhoid, malaria, tuberculosis, possibly amœbic dysentery, influenza, etc. The diarrhœa occurring in the course of a wound infection, of course, results from the poison circulating in the blood, and it is interesting to note that this diarrhœa may be either of the dysenteric type, or of the enteric type; that is, the movements may be small, mucous and bloody, or large and watery.

The Löffler bacillus makes no further incursion into the tissues, than the surface of the mucous membrane upon which it causes the diphtheritic false membrane to form. In diphtheria of the bowel, therefore, the diarrhœa results from the poisons elaborated at the surface of the mucous membrane. In thrush of the bowel, which occasionally occurs, less frequently perhaps in this country than in France, a similar condition of affairs exists. Ulcers of the bowels, whatever be their origin, form an excellent nidus for the growth of microörganisms; their secretions nourish these organisms, and afford a pabulum from which their poisons are elaborated. It is more than probable that the chronic forms of diarrhœa following summer complaint, and characterized by the formation of ulcers in the bowel, are maintained through poisons elaborated at the seat of the ulcers, rather than by the mechanical presence of the ulcers themselves. The recent researches of Councilman and Lafleur,* of Johns Hopkins, show that in amœbic

* The Johns Hopkins Hospital Reports, Vol. II., Nos. 7, 8, 9.

dysentery, the amœbæ abound not only in the intestinal contents, but also in the ulcerated bowel itself.

The last class of diarrhœas is that in which the poison producing the diarrhœa is elaborated in the intestinal contents themselves. The recent researches of Councilman and Lafleur just referred to, show conclusively that amœbic dysentery is to be put in this class. Poisons can only be formed in the intestinal contents by pathological fermentations and putrefactions of those contents induced by micro-organisms.

With the foregoing classification and remarks in view, I should define summer complaint as a disease or group of diseases produced by poisons developed in the bowel contents and characterized ordinarily by diarrhœa, sometimes by constipation, frequently by fever, by depression of the heart, by engorgement of the kidneys, and by general nervous symptoms such as convulsions, coma, etc.

With this limiting definition in view I wish to consider with you to-day the etiology of summer complaint, and its pathology, including under the pathology, its morbid anatomy, chemistry and bacteriology. Upon the chemistry I wish to advocate a certain method of feeding which I have used continuously for five years and with the greatest satisfaction.

First as to the etiology. We find that summer complaint is a disease of infancy; it occurs most frequently under the age of two years. If we divide the first two years of life into periods of six months each we find this disease most common in the second period, that is, between six months and a year. Why is this question of age so important? It is a factor which we must take into consideration, for

it evidently has a great bearing on this question. An adult can eat, generally, what he pleases and it will not develop diarrhœal disease, but put a baby under similar conditions and that baby usually develops diarrhœa. Aside from all questions of diet and resistance, there must be something in that baby at that age which predisposes it to disturbance of the bowel. A child at that age is preëminently a growing animal; this is the period of growth *par excellence*; it is a time of life when the child is adding to its animal tissues; it therefore requires for its food a superabundance of animal matter. It requires, and naturally receives a larger proportion of animal food, that is to say albuminous material, than the adult does. And it is this very albuminous food, from which poisons that are capable of producing effects through the medium of the central nervous system, may be elaborated by microörganisms. All ptomaines and toxalbumins contain nitrogen, and must therefore be formed from the albuminous foods. You cannot produce out of starch a poison that will cause constipation, or fever, or cardiac depression, or any other nervous symptom except such as can be produced by alcohol, which is the only type of poison that can be produced from starch. The predominance of albuminous food necessary for the growing infant, is therefore a constant menace to it. The rapidly growing infant must have a highly developed absorptive apparatus. We find that the absorptive tissue of the intestinal tract exists in a greater amount relatively in the infant than in the adult. The so-called lymphoid tissue, that growth which makes up follicles, and which is scattered throughout the alimentary canal, is distinctly an absorptive tissue. We

must necessarily have for the infant, if it is to grow rapidly, a superabundance of such tissue, and that superabundance of absorptive tissue is present, but it carries with it its counterbalance of danger. If we have this absorptive tissue which can absorb the material for growth, it can and does absorb the material for disease. Poisons formed in the intestine therefore gain a much readier entrance into the organism of the infant than into that of the adult. So the important factor of age alone is a predisposing cause of diarrhœal disease because of the preponderance of proteids in the food of the infant, and because of the high development of its absorptive apparatus and also because of the diminished resistance, which the tender age implies.

The reason why deaths from diarrhœal disease do not occur more frequently in the first six months than in the next six months is because children are usually more properly fed during the earlier period. Children may be kept at the breast exclusively during the first six months, but rarely are they so kept at the breast during the second six months.

Prominent among the conditions that produce this disease I would mention bad hygienic surroundings. People who live in poverty have more of this trouble than those who are more favored. Those of us whose work is in the large cities, come in contact with the tenement population, who live, sometimes, one or more families in a single room and whose surroundings are such that they cannot be clean. Anyone who had to endure the surroundings and the mental depression these people have to endure would be dirty. And they are dirty, they can't help it; what they eat is dirty, what they give to their chil-

dren is dirty, and bowel troubles among their little ones are frequent.

Another prominent factor in this disease is artificial feeding. Take Hope's very instructive report; out of a thousand cases of death from summer complaint he found only thirty who had been fed exclusively upon the breast. Meinert, of Dresden, investigated 602 cases of fatal summer complaint and only twenty-four out of these had been fed exclusively upon breast milk. This tells the tale we all know; I don't care to dwell upon it.

The question of atmospheric heat is very important. The term summer complaint has been given because the disease occurs most frequently in hot weather, but we have cases in winter, so that the term summer complaint is only true so far as it indicates that the trouble occurs most commonly in summer. Here come in the statistics worked out by Seibert, of New York, and Meinert, of Dresden. The mortality from this disease in May is but slightly greater than that in January, and yet the mean temperature is considerably higher. In June there is a considerable increase in the mortality, and in July a very great increase in the mortality from this disease. The observations of Seibert and Meinert show very clearly that as the mean atmospheric temperature approaches 60° F. diarrhœal diseases among infants increase in frequency, and when the minimum daily temperature does not fall below 60° F. these disorders become epidemic. The magic figure is 60; this is the temperature at which most microörganisms begin to thrive. At 32°, or the freezing point, microorganisms remain quiescent, but as the temperature rises their activity increases, and when it reaches 60°

they have reached a point where they begin to grow rapidly, and when the thermometer is above 60 their growth is maintained and they rapidly increase; if below 60 they are retarded in growth. It can hardly be doubted but that very hot weather has also a direct detrimental influence upon the infant. Weaning is frequently mentioned as a cause of diarrhœa. There is nothing in the act of weaning itself to cause diarrhœa. But when a child is weaned, it receives a larger quantity of so-called "table-diet," with a corresponding increase in the chances for introducing pathogenetic microörganisms.

Direct infection certainly plays an important rôle. In a foundling asylum, with which I was connected several years ago, we at one time received a baby with diarrhœa, characterized by a peculiar kind of stools. That baby was passing five or six dark brown, terribly offensive stools daily. Not another child in the institution had just such stools, although they all had diarrhœa, but within three days there were several cases just like the new one. I am satisfied that the particular kind of diarrhœa present in that case was produced by a particular kind of germ, whether one, two or three I don't know, but I believe that that germ got into the food of the other children and produced the same sort of disorder. In other words, there was a direct infection. In that asylum, I instituted a custom of putting the napkins, as soon as they were soiled, into a tub containing a solution of corrosive sublimate. The result was not only a deodorizing of the offensive diapers, but an improvement in the condition of the babies. I am satisfied that infection in the production of summer complaint is very important, and one of the factors which we

often overlook. Do not forget that infection can occur by way of the anus.

Holt, of New York, who has done a great deal of work in this line, holds that there is always a preliminary dyspepsia in this disease; that before diarrhœa commences the child for several days has abnormal passages, with possibly some disturbance of the stomach; has a little nausea; its appetite is deranged, and an indefinite general something is present which he calls a preliminary dyspepsia, and he regards this condition as a most important factor in the causation of diarrhœa. I can readily understand that if there is present a catarrhal condition of the bowels, an abnormal condition of the secretions of the bowels, that this may favor the development of the microörganisms producing this disease, but I cannot say that my own clinical observation fully upholds this particular point; I cannot say that in the majority of these cases coming under my observation there is a preliminary dyspepsia. I have looked for it, but I am unable from clinical observation to confirm Holt's statement in toto. Nevertheless, there is in a minority of the cases a preliminary abnormal stage, the nature of which I do not understand, which precedes the actual diarrhœa. It is not necessary to invoke the idea of an indigestion. It is more likely that the pathological microörganisms of this disease develop in the products of normal digestion, constituting processes properly called superdigestion.

The constitutional condition of the child must also be considered. It is more liable to diarrhœa if its resistance to disease has been diminished by premature birth, syphilis, tuberculosis, rickets,

scurvy, or preceding exhausting diseases of any kind.

I feel that we are in a position to state that all the etiological factors in the production of summer complaint may be classified under three heads: First, means which favor the contamination of food by microörganisms, and their growth in that food. Second, means favoring the introduction of microörganisms into the intestinal canal and the formation of poisons there. Third, conditions which diminish the child's resistance.

Let me present the following summary of the etiological factors of summer complaint:

- I. Means favoring the contamination of food by microörganisms, and their growth therein.
  - 1. Uncleanly surroundings.
  - 2. High atmospheric temperature.
  - 3. Infection.
- II. Means favoring the introduction of microörganisms into the intestinal canal, and the formation of poisons there.
  - 1. Artificial feeding (in whole or in part).
  - 2. Weaning.
  - 3. Overfeeding.
  - 4. Preponderance of proteid food.
- III. Conditions diminishing the child's resistance.
  - 1. Age.
    - *a*. Natural delicacy.
    - *b*. Preponderance of absorptive tissue.
  - 2. Atmospheric heat.
  - 3. Preliminary dyspepsia.
  - 4. Constitutional Conditions.
    - *a*. Premature birth.
    - *b*. Hereditary diseases.
    - *c*. Rickets.
    - *d*. Scurvy.
    - *e*. Other debilitating influences.

Very important information has been furnished by bacteriological investigations in this disease.

Booker,* of Baltimore, and Jeffries,* of Boston, have taken from the stools of babies suffering with various forms of cholera infantum and summer complaint,

* Trans. Amer. Pediatric Soc., Vol. I.

specimens, under the most careful and rigid conditions. They introduced double sterilized tubes into the bowel of the child and obtained some of the contents as they came out of the bowel, and investigated these specimens carefully as to the microörganisms they contained. The results obtained by these gentlemen are absolutely classical, and it is gratifying to know that Americans have done this exceedingly laborious work. They tried to find out what they could about microörganisms in the stools of children suffering from summer complaint, and what did they find? Millions and millions of microörganisms. The very fact that we have a foul stool shows that we have a fermenting mass in which microörganisms are growing. From the stools of thirty infants suffering from various forms of diarrhœa, Booker separated forty varieties of bacteria. This by no means represents the whole number of varieties present, as the methods of bacteriological examination in use at present do not permit so complete an examination. The greatest number of varieties found in any given case was eight, but no one kind of organism was found in all the cases. Organisms of the proteus group seemed to predominate in the severer cases.

Three of the varieties separated by Booker were investigated chemically by Vaughan,* of Ann Arbor. Vaughan grew these separately in cultures of beef broth, and passed them through Pasteur filters, thus separating the germs from their chemical products. From each of the sterile cultures he separated a proteid poison. Each of these poisons, when injected under the skin of kittens or dogs, produced vomiting and diarrhœa, and when administered in sufficient

* Trans. Amer. Pediatric Soc., Vol. II.

quantity, collapse and death followed. In other words, he obtained poisons which were capable of producing the advanced signs of summer complaint as we meet them in the baby. Each poison was a proteid, and each different from the others; he found that none of the three were alike, he could recognize a chemical difference. So there are at least three poisons we know of that will produce summer complaint and they are no doubt the same poisons that are in the intestinal canal, the same poisons that produce the stools. We have three, but we need not stop at three, we may assume that there are many kinds of microörganisms, and that there are many different kinds of poisons which are capable of producing this disease.

Now if that is the condition of the bowel in a child suffering with summer complaint, what is the condition of the bowel in a child that is perfectly healthy, in the breast-fed baby having normal stools? In the first place, when a child is born, its bowels contain meconium, which is sterile, but within seven hours microörganisms have gained entrance to the meconium through the anus and the mouth; within seven hours after the baby is born, whether it has taken a drop of anything or not there are microbes throughout the intestinal tract. Within a few hours the meconium that the baby passes is found to contain an exceedingly large number of microbes, and they are not only numerous but they exist in great variety. When the child begins to feed at the breast, we find the character of the stools changed and the ordinary yellow stool of the breast-fed baby takes the place of the dark brownish green meconium originally present. With this change in the stools, a great

change in the variety of microörganisms discharged from the intestinal canal also occurs. The microorganisms formed in the meconium disappear and in their place we have two, the bacterium coli commune, and the bacterium lactis aërogenes, which make up the great bulk of the bacteria present. There are also some accidental forms, but the two named are constantly present, and are characteristic of the milk stools of the healthy infant. This is an exceedingly important fact. It shows that healthy milk stools are capable of supporting only a small variety of microörganisms, and even though the bowel contents were contaminated by a wide variety of microörganisms before the milk of the mother's breast was put into the child's bowel, as soon as the milk does reach there, just so soon do these microörganisms die out. They die because the food they need to maintain life is gone; they die because the food going into the canal is not capable of sustaining them. And this supplies us with the keynote to the handling of the bowel complaints of children by dietetic measures. If you have in the intestinal canal a mass of microörganisms that are living upon a certain kind of food and producing poisons which are causing diarrhœa or depression, and you take that food away from them, you will kill the microörganisms by a process of starvation; you can't get them out in any other way. That the starvation plan is possible, is shown by the change which normally occurs in the bacteria present in the intestinal canal of every healthy baby when the milk stools appear. Practically I know it is possible also in intestinal diarrhœal troubles. So far as microörganisms go we know they are producing

some result; what do we find pathological in these cases? I shall have a word to say upon the morbid anatomy of summer complaint, and only a word, as I do not regard this factor as of the highest importance. The best exposition of the morbid anatomy is that of L. Emmett Holt,* of New York. He investigated a large number of cases anatomically and microscopically and found that if a child had summer complaint for a day or two and died as a result of severe cholera infantum there was not found at the autopsy any serious lesion of the bowels; there might be a little desquamation of the epithelium but nothing more marked. If, however, the child died after a week's duration of the disease more marked lesions were found. By this time the lymphoid tissue of the solitary follicles was involved. These little absorbing masses of lymphoid tissue were thickened. With a greater duration of the disease, the swelling of the follicles resulted in more or less destruction of these bodies, with ulceration. Ulceration was not found prior to the second week of the disease, and extensive ulceration, involving other structures of the bowel, can only be considered well established when the disease has lasted three weeks or more. The most marked lesions were found in the colon. To my mind, this involvement of the lymphoid tissue, and the progress of the lesions coincidently with the duration of the disease, is most significant.

Why does the lymphoid tissue swell? Wherever we find lymphoid tissue we find it swelling when poison comes in contact with it. If poison comes in contact with the tonsils they swell; if poison passes through a so-called lymphatic gland, it swells;

* Keating's Cyclopedia of Diseases of Children. Vol. III.

and so it is in the intestines. Poisons are formed there, in the mass of putrefying contents and when these poisons pass through the lymphoid tissue, they cause it to swell, and finally, from the interference with its nutrition thus produced, to break down and form ulcers. The poisons which have passed through this tissue are evidently the same that have caused the diarrhœa; the same that have produced the other symptoms in the case. Therefore I say that the anatomical conditions present in cases of this kind are but the results of the poisons produced in the intestinal contents and in no sense the cause of the disease. Strümpell, in discussing tuberculosis of the bowel, says that in the diarrhœa of tuberculosis there is not always found post-mortem, that tuberculous disease of the bowel itself exists, and furthermore, when advanced tuberculous disease of the bowel does exist and is shown post-mortem, the symptom diarrhœa has not always existed during life. In other words, these anatomical lesions have nothing whatever to do with the production of the diarrhœa; they are part and parcel of the symptoms which are produced by the poisons elaborated in the bowel contents. Chronic diarrhœa is produced when a simple diarrhœa has lasted about three weeks. After three weeks ulcers form in the intestinal walls and microörganisms thrive on the surface of these ulcers which secrete and pour out a certain amount of albuminous material, and this blood serum, or whatever comes out, forms a medium in which microorganisms can grow and manufacture their peculiar poisons; so that if ulcers are present, the microorganisms find a food on the surface of these ulcers aside from the food they have in the intestinal

contents, and therefore, by simply modifying the intestinal contents we do not reach the whole cause of the diarrhœa. So I would say that a chronic diarrhœa following summer complaint or cholera morbus is maintained by poisons developed on the mucous membrane of the intestines.

With these views of the pathology of the disease, it is easy to understand the wide range of symptoms presented by it, as well as the great variations as to severity which it presents. It becomes unnecessary to speak of the desquamative, catarrhal, or mucous forms of the disease, or to attempt to recognize the follicular form. The severer types so often called "true cholera infantum," do not need to be put into a special category. Theoretically at least, there is no limit to the variety of poisons which may be produced in the bowel contents, and no limit to the symptoms which may be thus invoked. Very frequently do we find putrefaction of retained fæces, with the production of various symptoms through the medium of the nervous system, and sometimes it seems that these very poisons produce constipation and favor the retention in the bowels of the putrefying masses in which they have their origin. For this reason it has seemed to me desirable to include putrefactive constipation under the generic term "summer complaint." No doubt a better name than summer complaint could be devised, but it is the least objectionable designation of the summer diarrhœas, and the close relationship, both in pathology and treatment, between summer diarrhœas, and putrefactive constipation, makes the extension of the term at least allowable.

CHAPTER III.

SYMPTOMATOLOGY AND TREATMENT OF SUMMER COMPLAINT.

The most prominent symptoms in summer complaint are those connected with the bowels. The diarrhœa is characterized by stools which differ from each other greatly, as to number, consistency, color, and odor. Of the several phases of the stools, the odor is the one to which I wish to call particular attention. It is indeed remarkable with what certainty the stools may be divided by their odor into putrid stools and acid stools. Occasionally the stool will be described as having an intensified fæcal odor, or smelling like old wood, but it is evident that such odors are but variations of putridity. The acid stools derive their odor from the presence in them of various members of the fatty acid group, all of which have arisen from superdigestion of carbohydrates. The putrid stools, on the other hand, can only arise from fermentations of albuminous materials. I told you in my last lecture that we know of no poisons that can be produced by the fermentation of the carbohydrates, alcohol excepted, that can produce symptoms on the part of the nervous system, but that all the poisons that we know of, which are capable of producing symptoms through the medium of the

central nervous system, and which may be formed from foods, are nitrogenous poisons. Let me recall some of the nitrogenous poisons: Every alkaloid which a vegetable contains is a nitrogenous product; morphine, quinine, atropine, the whole long list of vegetable alkaloids contain nitrogen; the long list of animal alkaloids, the ptomaines and leucomaines, contain nitrogen; every one of the toxalbumins contains nitrogen. The stools of putrid diarrhœa are liable to contain nitrogenous poisons. Why? Because putrid products can occur only from the fermentation of nitrogenous material. It does not follow because a stool is putrid that it contains poisons, but it shows that it has been formed by the fermentation of proteids and therefore probably contains poisons. If, on the other hand, it is sour, it shows that fermentation has been maintained by the carbohydrates, from which such poisons cannot be elaborated. Baginsky* says that one stool may be sour and the next one putrid, the next one sour, and so on, from the various forms of fermentation that may go on in different parts of the intestinal canal at the same time. Theoretically this is true, but practically it is not. When we find a child passing putrid stools it continues to pass putrid stools for several days, and when it passes sour stools it continues to pass sour stools for several days. The acid form is a milder form of the trouble; it produces agents which act locally only, whereas the putrid form produces agents which act through the central nervous system; therefore, if we are able to transform a putrid diarrhœa into an acid diarrhœa we eliminate certain definite sources of danger. We may have a putrid and a

* Deutsche Med. Woch., May 24, 1888.

sour fermentation going on at the same time, the sour fermentation being masked by the more pungent odor of the putrid fermentation. But the putrid fermentation is an indication of danger. My friend Dr. Rachford, of Newport, Ky., has called attention to the fact that if we have fermentation of proteids with the formation of poisons, whether there happens to be putridity or not, there will be symptoms referable to the central nervous system, and therefore if we have such symptoms due to poisons formed in the intestinal canal, whether with or without putrid stools, we should treat the case in the same manner as I shall teach you to treat putrid stools.

We may have stools which are large and watery, we may have stools which are small and more or less coherent. The stools may be characterized by containing blood and mucus, they may be accompanied in their passage by pain, or by straining, or by bearing down, tenesmus; they may be characterized in color by being pale or yellow or green or brown, but every one of these changes is referable to the variations in the fermentations in the bowel. It seems certain that the green stools of summer complaint are due to certain chromogenic bacteria, but the green stools are by no means the worst.

In many cases where the stools are green, due to the growth of certain chromogenic bacteria, we have no general systemic trouble, but on the other hand, where we have rather innocent looking stools, nothing but a little rice water discharge, our patient is seriously ill. In every such case of cholera infantum there have always been putrid stools at first, and they are no longer putrid simply because everything has

been washed out of the bowel. My own experience is, that brown stools are the most foul in point of odor, and the most apt to be accompanied by severe symptoms on the part of the general nervous system. The variations in color are unquestionably due to the variations in growth of the microörganisms in the intestinal canal, but may sometimes be due to the food. Mellin's food, for instance, produces a brown stool, but such stools are innocent. Some of these patients have fever and some have not. Why? Simply because in some instances poisons capable of producing rise in temperature are formed, in other instances poisons of this kind are not formed, so in one case we have fever and in another we do not. Fever is then purely an accidental condition. Again, we may have on the part of the brain such symptoms as convulsions. But convulsions are not due, I take it, to simply the draining away of the serum, which the large number of movements has produced, but to the action of a convulsive poison, something that can directly induce convulsions, a substance with a strychnia-like action. Another point of importance is the question of coma in these cases. Some years ago, when I treated these cases exclusively by opium, I used occasionally to find a little one with what I considered opium poisoning. Later, after I had stopped using opium, once in a while the same kind of case would occur. On questioning the mother I would find that no opium had been given outside of my direction, and something else must be at fault. I see several such cases every year, characterized by contracted pupils, stupor, sometimes coma, by slow respiration and slow pulse. Now there has been formed in the bowel of that child a poison which acts

like opium and produces these symptoms. How shall we get rid of it? I have invariably given the nitrate of potash and water, and in the course of two hours, invariably profuse urination has occurred and with it all symptoms have disappeared; in other words, the poison has been washed out through the kidneys. Here, then, is one set of symptoms which is evidently produced, so far as clinical information can teach us, from something developed in the bowel. Again, we have patients troubled with insomnia, and it is likely that this sleeplessness is caused by poisons produced in the same general way. Now let us take up the question of depression, for that is the most important one. Our little patient is weak, the fontanelle has sunken, the eyes have sunken, the skin is cold and the pulse indicates collapse. Now to what is that due? Is it because the baby has had four or five or a dozen stools that day? No. If you had given the baby sulphate of magnesia there would be the same loss of serum. Would the child be in that same bad condition? No. There is another element there besides the number of stools. I believe the mere number of stools is of secondary importance. The question of loss of fluids we have been taught to think much of—too much indeed. But let us suppose we had introduced a motor depressant into this child's blood, say conium or curare, what would have happened? Almost the same condition of collapse. It is evident that the collapse has been produced by some poison, and not simply by the number of stools that have been passed. If we believe the collapse to be due wholly to the number of stools we would most rationally proceed to stop the stools; we would give the child opium, tannic acid or anything

to stop the flow from the bowels. But if it is due to a poison that has been formed in the intestine, what are we to gain by stopping the number of stools? Nothing. We may even do damage by retaining in the bowel the source of the trouble. I beg of you, then, to regard summer complaint as presenting various phases, but due entirely to poisons formed in the intestinal canal. On the other hand, we find that sour stools cannot produce poisons of this kind, but still we have movements from the bowels, and we can only explain the phenomenon on the ground that the products of acid fermentation are directly irritating to the mucous membrane of the bowel and act by locally stimulating the bowel, by locally increasing its functions. But remember that such irritations do not and cannot produce collapse; that they do not and cannot produce coma; that they do not and cannot produce convulsions; all the serious conditions are thrown to one side and only the local ones of increase in the number of stools and pain remain. Now then, here comes in the explanation of Dr. Rachford. If these depressed conditions occur, no matter what the number of the stools may be, the trouble is due to poisons formed from nitrogenous material. If we can stop the proteid fermentation, even if we have to leave an acid fermentation, we shall make a decided gain for our patient.

Now as to the treatment proper. It consists of two general steps: first, to remove the cause, second, to repair the damage done. These two steps apply to almost any disease, but particularly to this one.

First, remove the cause. How? We have found that the cause is due to certain fermentations going

on in the bowel; let us get the poisons out of the bowel. How? By the use of laxatives first. To empty the bowel of a baby, gentlemen, is a work of art; it is not a simple thing. We can give a dose of castor oil and have a certain number of stools produced; we can give a dose of calomel and have a certain number of stools produced, but we are by no means certain that we have emptied the bowel of the child. Don't forget this point; it is exceedingly important. I shall refer to it again. My preference by way of preliminary cathartic is calomel in grain doses four hours apart until three grains are taken. I give a child six months old one grain of calomel every four hours until it has taken three doses. Sometimes a child may be having eight or ten stools a day; you give it calomel and it will be brought back the next day with a report of four or five movements instead of the increase you had reason to expect. I cannot explain this phenomenon, but it occurs with sufficient frequency to attract attention. The actual number of stools will be diminished under the action of the cathartic, and what is more, the child will be better, irrespective of the number of stools. Sometimes the number of movements will be very much increased; the child will be having four or five a day, and after taking the calomel it will have eight or ten or more and yet be better. I have never seen any bad results from the use of calomel, although bad results are reported under such circumstances, but I have prescribed it so many times and given it to so many babies under these circumstances that I have no hesitation in giving it, in the quantity mentioned, to a child six months or older; the quantity need not be increased for older children. If too

large a dose is given it is simply swept out of the bowel; there is no such thing as giving too much in order to purge freely. But understand, that the calomel empties the bowel only partially, and by no means does it always get everything out. What shall we do next? To still further empty the bowel I would recommend the use of copious injections of water, and they can be introduced either with or without the aid of a rectal tube. The quantity of water to be put into a child's bowel is something to be considered. In one method of irrigation, the water is allowed to run in and out at the same time. By that means only the lower part of the bowel can be washed. My plan is to fill the bowel with water. I want to reach the cæcum, because there is where most of the trouble lies, where the greatest amount of damage has been done, where the autopsies prove that most of the poisons have been absorbed. Because there is where we have the most ulcers, and no matter whether we have enteric disease or dysenteric disease symptomatically, the actual lesion is in that part of the colon. I put into a child a year old a quart of water at a time, and it will hold it. This seems rather a large quantity, but patient after patient I have had in my clinic, brought before the class for the distinct purpose of showing them how much water a child will hold, and it is remarkable how much they will take. I set the quart as a limit; a half gallon will nearly fill an adult's colon. But some judgment must be exercised with regard to the quantity used; if you have reason to believe that the bowel is badly ulcerated and liable to be torn because of pressure, you should not put in such a quantity of water, but in an ordinary acute case you can

put a quart in. A fountain syringe is the safest means of introducing the water. When it is in it runs out again, of course, as soon as you take away the tube. But the bowel does not completely empty itself at once. The mother will tell you that the child passes about a pint and then stops, and the remaining water will come away in about twenty minutes or half an hour. Do not put into the water you use to wash the bowels, any poisonous antiseptic; do not use bichloride of mercury to wash the bowels, because you might have enough of it stay behind to produce poisonous symptoms. It is not needed; clean water is quite enough. The object of the water is to wash out the bowel and clean out the little loculi. You remember in the large bowel there are little pockets at one side which form convenient places for fæcal matter to lodge in, and when we give a brisk cathartic like calomel, it strikes right past these pockets and does not clean them out; but with the slow washing out of the bowel the water will seek out these pockets, and clear out their contents. Very frequently these masses of retained fæces are the sources of the poisons. This illustrates the substantial identity of putrefactive constipation and summer diarrhœa, and justifies their being included under a single term.

Now we have gotten this bowel clean, apparently so, at least, by means of the preliminary purge and the washing. So far so good; but we have only taken out of the bowel the larger mass of material there present, we have not washed it clean. You could not sterilize in that way a test tube, and much less, so complicated a tract as the bowel. You have not got it clean, but you have got the bulk of the material

out and you have removed the bulk of the poison, but the germs remain behind, at least enough of them to set up the trouble again. The baby will probably seem better, some of the symptoms have disappeared and the child is undoubtedly better, but we want to kill the germs there, we want to kill the particular germs that are producing the trouble. How can we do it? We have at our disposal a large number of intestinal antiseptics, the best among them are unquestionably calomel and bismuth. The calomel which we have originally given acts as an antiseptic, but its action is only temporary, it does not and cannot sterilize the bowel. If we wish to use it still further as an antiseptic we will give minute doses of one-tenth or one-twelfth of a grain every three or four hours, but the results will be only partially satisfactory. Next to that our best antiseptic is bismuth and to employ it successfully as an antiseptic we must use it in massive doses. The dose of bismuth, like calomel, is not to be measured with great accuracy. I usually give a dose of ten to fifteen grains three or four times a day to a child six months or a year old. Bismuth does not produce any systemic effects, but you want to give enough to produce an effect in the intestinal canal, and two or three grains of bismuth are not enough. There is one objection to bismuth. Besides being an antiseptic, it unquestionably is, to a certain extent, an astringent. Many times I have thought the diminished number of movements following the use of bismuth were due to the curative effects of the drug and that the poison had been destroyed, but I have reason to believe that it was really due to the astringent effect of the bismuth, and this effect in the early stage of the treat-

ment is not desirable, because it retains the poisons we want to get out. Then there are naphthalin, salol, resorcin and a whole host of drugs of that type, but they are unsatisfactory. Fortunately we have a much better means at our disposal. Suppose we have a diarrhœa and the stools are distinctly putrid; we know there has been fermentation and that the germs producing it are living on proteid material, so we simply keep that kind of material out of the bowel and starve the germs; there you have the keynote of the whole method of feeding. Starve the germs, do not try to get them out with chemicals, because you cannot do it. You accomplish something in that way but you cannot kill them all. But when the child has a putrid diarrhœa you must keep away from it all proteid material, keep away meat, fish, milk and eggs. Keep away those foods which are capable of undergoing putrefaction. It is hardly possible that the child has been having meat or fish, but it may have been getting eggs, and almost certainly has been receiving milk. Milk has probably been the chief diet of this child before it was taken sick, and the proteids of milk are what the germs in that intestinal canal are best adapted to live on. Above all things, stop milk; that is the first thing to do when you have a putrid diarrhœa. Do not be led into giving milk because the books tell you that it is a bland and non-irritating diet. That means nothing. We are not trying to save that bowel because it is in an irritated condition, but we are trying to prevent the formation of poisons, and therefore we will keep out of the bowel material from which they can be formed, and that is in this instance proteid material. Now if we have to keep proteid material out, what shall we

put in? Anything which cannot support the obnoxious germs; anything which will starve them out and still be food for the child. The books tell us that in severe cases we should stop all food. If we stop all food we can certainly starve the germs, but it strikes me we are going to starve our little patient also, and put a strain upon him that is unnecessary. If we must take away meat, fish, eggs and milk, let us give him the starches and sugar. Many years ago Moore, of England, advised that these cases be fed on cane sugar exclusively. Such a diet is right, but you don't need to limit them to cane sugar; give them starches. I take a child six months old with putrid diarrhœa and give it arrow root, or rice, or crackers, or baked potato, but not milk. But you look surprised to hear me advocate potatoes and crackers—solid food in diarrhœa. When we have the theory of this disease that I have attempted to give you, that it is not due simply to an irritated condition of the bowel, why not give solid food? I assure you, from a personal experience of several years in this matter, that solid foods of proper chemical composition act most beneficially. Milk is a solid food; it is not liquid. It is only liquid before ingestion. The first thing that happens to it in the stomach is coagulation, so that it is probably more irritating from a mucous-membrane standpoint than any amount of starch. We are told these babies cannot digest starch because they have no salivary secretion and no distinct pancreatic secretion. I will admit the physiological statement that their salivary and pancreatic secretions are both deficient, but I deny the other statement. It has been assumed that because these two secretions are deficient, that infants cannot digest starch; but we

all know of babies who have been given arrow root from their birth, and who have digested it perfectly. We all know that babies can and do digest starch; they do it daily. There is hardly a secretion in the body but is capable of digesting starch so that it can be absorbed. Right here I wish it to be understood that I do not advocate starch as a continuous food for infants, but I am speaking of its use for temporary purposes; it does help the child along when it is poisoned; it does serve a purpose with the child when we want to take away other kinds of food, and in giving starch we have the advantage of not depriving the little one of all food. How about predigesting the starch? We do not need to predigest the starch; the great bulk of children can digest starch, particularly the small amount necessary for our purpose.

I told you that milk was bad for this condition; how about peptonized milk? Peptonized milk is worse. Why? I know some of you have used peptonized milk, and in some cases with good results, but I wish to assert that if you did get good results in those cases, you could have gotten better results in some other way. This preparation is generally bad. In the first place, it is peptonized by means of a pancreatic ferment. If you will experiment by putting some hard boiled egg in a solution of pepsin and hydrochloric acid, and leaving it over night at the temperature of the body, in a suitable oven, you will find that it has not only digested completely, but that it has a peculiar odor that is not unpleasant; but take the coagulated egg albumin and put it with trypsin in an alkaline solution, and subject it to the same conditions, and you will find, as you open the

incubator, that it has a distinct fæcal odor. If you leave it a few hours longer, the fæcal odor will become stronger, and in a few more hours the odor will be unbearable. The mass has become putrid. Now the action of trypsin upon proteid material is to break it up in such a way that the germs of putrefaction can thrive therein. They thrive readily in the products of tryptic digestion, but not readily in the products of peptic digestion. The milk partially peptonized by this pancreatic extract, is only in a better shape to undergo putrefactive changes when it reaches the stomach and bowels. If you put it into a perfectly healthy alimentary tract, no harm will occur; but if you put it into a bowel that is already contaminated with putrefaction-producing microörganisms, you have only helped those microörganisms to the extent to which you have digested that food. Understand, I do not say that there are no conditions in which peptonized milk may prove useful, but am merely condemning its use in the putrid diarrhœa of infants.

Now about sterilized milk. It is practically pure so far as germs are concerned, but just as soon as the sterilized milk reaches the infected intestine, the germs there begin to develop in it. Sterilized milk, therefore, is not the proper food in putrefactive diarrhœa, because it has essentially the same chemical composition as any other milk, and it is the chemical composition that is guiding us at present, and not its bacteriological condition. Sterilized milk, therefore, should be used solely as a preventive; if we start with a healthy child and feed it sterilized milk, we run that much less chance of introducing pathogenetic microörganisms into the intestines, but

after they are once there, it has no power to get them out. Milk from the mother's breast does just as much damage as milk from any other source. Other things being equal, I would rather treat an acute case of diarrhœa in a bottle baby than in a breast baby, because I can give the bottle baby just what I want to. Frequently I would take the baby from the breast for thirty-six hours, keeping up the mother's secretions by the breast pump, and feed the baby as I would like to; but we cannot always do this, and where I cannot do it I find that I do not get as good results in treating diarrhœa in breast-fed babies as in bottle-fed babies; I cannot cure them so quickly because I cannot feed them right. Such a procedure is only necessary in severe cases.

How long is it necessary to withhold proteid food in acute diarrhœa? Twenty-four hours will usually suffice to correct the odor of the stools; at the end of that time stools which have been rotten will have lost their putrid odor, usually, and at the end of forty-eight hours they will certainly have lost their putridity. But it is desirable, where possible, to withhold proteid food for several days after the stools have lost their putridity. In chronic cases, where there is already ulceration of the intestine, the putridity is maintained by something besides the intestinal contents. Let us say the putridity has ceased, what will occur? Almost always the stools will become sour; in other words, an acid fermentation which has been going on in addition to the putrid fermentation continues, so that we still have left a cause for diarrhœa, but we have transformed a diarrhœa which was capable of causing nervous symptoms into one which is only capable of producing

local symptoms in the bowel; we have transformed a dangerous trouble into one comparatively simple. That is what has been gained by the method of feeding.

I think this will give you, in a general way, my idea of how to remove the cause. Remove it by purges, remove it by washing out the bowel, remove it by antiseptics, and above all by starving out the germs by withholding their proper food.

One other thing: that is washing out the stomach. It sometimes happens that we cannot by all these means at our disposal control things as we would like to, and it becomes necessary to wash the child's stomach. Washing the stomach, particularly where vomiting is present, is of great service, but you are not required to do it very often. I have had comparatively few cases in which it was absolutely necessary, but I believe if I had resorted to it more frequently I would have had better results, would have cut short more cases. But it is a very troublesome measure. Washing out the bowel is an easy matter, and can be done by the mother, but washing out the stomach is something you must do yourself.

The question of the treatment of vomiting in these cases is to be considered. The vomiting is probably not due, not always at least, to local conditions, but most likely it is due to the poisons produced by the various fermentations present, and it disappears when the poisons are removed. When it is present, however, it is a very serious complication, as it prevents us putting anything at all into the child's stomach. If persistent vomiting is present, we should always wash the stomach by means of the stomach tube, and this often gives relief.

We have removed the cause, how shall we repair the damage done? Ordinarily, with the removal of the cause, the child promptly recovers. But the matter is different in a severe case where the child has been seriously ill from a sharp attack of cholera infantum, and at the end of a few hours of illness is in a state of collapse; sunken eyes, sunken fontanelle and pale, cold surface; rolling the eyes about, opening the mouth, showing the dryness of the lips, etc. What shall we do? Evidently, in such a case, there is no time for delay, the damage is too severe, the poison must be directly combated. We will, of course, stop all food at once, because we cannot run the risk of doing that child further harm; particularly would we stop milk. We would wash the bowel as far as we could, for a double purpose, the one to remove from the bowel as much offending material as possible, although but little will be found; the other, to supply some of the fluids which have been lost. The water used should be as warm as can be borne. The peculiar depression must be combated by all possible means. First, by external heat in the shape of hot baths, and hot blankets wrapped about the child to stimulate it. Opium here is of great value; so also is belladonna, it directly counteracts the poison present, and is a very direct antidote to this particular condition. Another thing; if it is possible to get fluid of any kind into the child, do it. Why? Because that fluid will pass out again through the bowel, possibly through the kidneys, and as it goes it will wash out some of the poison which is doing the harm. Our object in a case like this is simply to support life. We cannot attack the case

on the lines I have given you before; we must counteract the poisons as well as we can by heat, belladonna, opium in small quantities, and by washing out as far as we can through the process of elimination.

In chronic cases, those which have lasted three weeks or more, the greatest good is accomplished by regular daily lavage of the colon. The use of intestinal antiseptics, particularly bismuth, is of considerable service. In long-continued cases, laxatives can only be used occasionally. While the diet is to be directed on the same lines as those already laid down, it need not be adhered to so absolutely.

We all have our type cases, of which we make much. Among mine is one which I should like to relate to you now: A rachitic baby, which had been under my observation for regulation of diet, was suddenly taken with convulsions. Apparently the bowels were in a pretty fair state at the time. The convulsions commenced at 4 o'clock in the morning, and lasted until noon. I first saw the child about 8 A. M. The temperature then was 102° in the rectum. I suspected the bowel as the source of the trouble, and endeavored to empty it. I gave the child calomel by the mouth, washed the large intestine, and gave by the rectum a small dose of croton oil in emulsion. Quite free purgation ensued, but the convulsions continued, and I was forced to think that they had their origin in some other cause, most likely the onset of some infectious disease. I was finally reduced to the necessity of administering chloroform to control the convulsions. In the afternoon the convulsions returned, and the temperature rose very rapidly until it reached 107.5°. Cold baths and antipyrin were

employed without success in combating the temperature. What was making this temperature? Just before the little one died, it passed a mass of the most putrid fæces I ever smelled. There was the source of the trouble; it was absorbing poison from this mass, and if I had continued trying to empty the bowel, possibly I could have saved that child.

Now, then, to repair the damage done, we must meet the symptoms as they come up. If the child has fever we should endeavor to meet the temperature by sustaining the child's strength with alcohol and by producing sweating. If the temperature be high you can produce sweating in several ways. One way is to sponge the body over with almost ice-cold water, then wrap the child up well; there is an immediate reaction. The skin becomes red and soon there is profuse sweating. This can be done with a baby where you could not do it with an adult. So we take the temperature down, as in any other disease, but particularly do we look to the bowels as the source of the trouble in these cases. In those cases where the temperature runs up to 106° and 107°, and which are sometimes called sunstroke, the trouble is probably always in the bowels, and you should remember that even after you have given a cathartic you are not through with the bowels until the symptoms cease.

I should like to say a word regarding the opium treatment of summer diarrhœa. For a number of years I treated these cases with opium. There can be no question but that good results can be obtained many times by the use of opium. In the first place because of its stimulant effects, and in the next place because it relieves the pain and thereby strengthens

the child. If used in the shape of a Dover's powder, it acts as an eliminant and we have some of the poisons thrown out, and in general it is a direct antidote to the poison, so that the use of opium amounts to treating the poison by a direct antidote instead of treating the disease by getting rid of the poison. It is not so illogical as one would imagine, but I don't think the treatment is good; relapses, so-called, are more apt to follow the opium treatment than the plan which I have outlined.

Another thing please do not forget; that is, that you are at all times treating the baby, and not the disease. Never treat a case of putrid stools, but be kind enough to treat the baby who is unfortunate enough to have those putrid stools. We see cases where the child is passing the most abominable stools, and yet it may be well, happy and lively; don't put such cases amongst those I have asked you to treat; they are going to do well enough if you will let them alone. We must use judgment in these things. We have many cases come to us that fortunately do not present the exact conditions for interference on the lines I have laid down for you; and remember they do not need any such interference; they will get well if you wash out the bowels. You must remember that it is not simply the putridity that directs you to interfere, but the continued severe nervous symptoms accompanying it.

Suppose the stools are already sour, resulting of course from the superdigestion of carbohydrates. Theoretically, you would have to keep out the starches, but what have you to fall back upon? Nothing in the world but white of egg. At one time I tried this plan, with the result that I succeeded

in changing acid diarrhœas to putrid diarrhœas. A sour diarrhœa we can treat with bismuth and complete withholding of food, or the use of milk. The milk will keep up the sour diarrhœa because of the sugar in the milk, but it is the best we can do. It is but rarely necessary in this form of the trouble to stop all food. Remember that a sour diarrhœa is not ordinarily dangerous. We can also give opium, and this is the place where we may want opium. The acid produces pain in the bowel and also flatulence. The gas does not cause the pain; it is the acid that causes the pain. Lavage of the bowel can also be profitably employed. The acid form of the trouble is not so amenable to dietetic treatment on the plan I have given as is the putrid form, and we must treat it on other lines, principally by the use of lavage and intestinal antiseptics, and occasionally opium, as already suggested.

NOTE.—Escherich was the first to classify the diarrhœal diseases of infancy, with reference to the food fermentations, and to advocate a method of feeding based upon such classification. (Jahrbuch für Kinderheilkunde, Bd. XXVII.) My first publications on this subject were made before I learned of Escherich's work, and appeared in the Cincinnati Lancet-Clinic, June 18, 1887, and in the Philadelphia Medical News, March 9, 1888. The present lectures express my views upon the subject as modified by the clinical work of five summers.

CHAPTER IV.

PRINCIPLES OF INFANT FEEDING.

What I propose to give you to-day will be probably more in the nature of suggestion than instruction. I may possibly be rather more iconoclastic than constructive. I wish to take into consideration certain of the principles which underlie the subject of infant feeding, rather than all the details which go to make up successful work in that direction.

We find it stated that human milk is the best food for the infant; we find it further stated, and generally accepted, that in the absence of human milk, that food which most closely resembles mother's milk in its chemical and physical properties, is the best for the infant. Now I wish to deny this latter statement, and it is rather difficult to show cause for the denial, for a lie that is partly true is the hardest of all to down. It is unquestionably true that mother's milk is by all odds the best food for the *healthy* infant. Let us get that word healthy well fixed in our minds. That it should be made the guide in the formation of any artificial food for the healthy infant is likewise true, but that it should be followed absolutely, that we should bow down to it exactly and never vary from it even in the slightest particular, is not true. It is not true, for instance, that we must have

a milk which shall coagulate exactly as mother's milk does in order to be successful as food for a baby; it is not true that we must have exactly the same proportion of the several ingredients which enter into mother's milk, imitated in our artificial food. In consequence of the general conception we find that the efforts of chemists and of physicians have been directed towards imitating mother's milk as closely as possible. We are told to take the milk of goats because it resembles mother's milk more closely than does cow's milk. But it is not practical. We cannot obtain goat's milk in sufficient quantity, but we must look to cow's milk for artificial food for the child. Furthermore, goat's milk contains widely different substances from anything found in mother's milk or cow's milk, certain organic substances the nature of which we do not understand. But the presence of these is ignored completely when the quantities of proteid and sugar and fat are tolerably near those in mother's milk. Meigs has done considerable work in this direction. He prepares a food by taking certain proportions of cream, milk, water, and sugar of milk, the latter in large quantity, and makes what is known as Meigs' cream mixture, or artificial food for babies. The mixture has not proven satisfactory in my hands. And I may say here, that with cream mixtures as a rule, more or less trouble will be experienced. I have had my attention called quite recently to a number of children who have been raised upon a mixture of cream and oatmeal alone, and it is strange to see what peculiarly healthy children can be produced by this mixture. That is to say, apparently healthy, for as we shall see later, they are certainly not completely nourished children.

We must throw aside then the idea that we must imitate mother's milk exactly.

The first rule for any food is that it must comply with the conditions met with in the intestinal canal of the particular infant in question; the food, to be successful food for a baby, must be suitable to the conditions found in the intestinal canal of that baby. Let us see what we mean by this. In the majority of instances when we are called upon to direct the feeding of a child artificially, that child has already had its alimentary canal disordered, it has already been tampered with, and it is comparatively rare that we have an opportunity to take a new-born baby and from the start direct its feeding as we wish; it is nearly always in an abnormal condition when we take charge of it. How? There are conditions which we may call dyspepsia, if you please, diarrhœa, or what not, but in nearly every instance the child has some abnormal condition of the alimentary canal. Let us suppose that when the baby is brought to us it is having putrid stools; shall we put it at once upon a certain kind of food because it is considered the best for a baby; shall we put that baby to the breast or on food which so resembles mother's milk that it might, *a priori*, be considered the best? By no means. We must first put that alimentary canal in the best condition, and the food we adopt for the time should be the one we would prescribe for the diseased condition there present at any other time. This is an important thing in artificial feeding, but frequently overlooked. So often the child is brought to us with the statement, "Doctor, we want you to direct the feeding of this baby; we have tried this and that food but none of them have agreed with

the baby." We can't tell what food agrees with that baby, but what they have proved is that this or that food does not agree with the conditions present in the intestinal canal. Let us remember that the first condition of infant feeding is to put that child's bowels in a normal condition, and right here come in the principles I have explained in my preceding lectures, because the conditions I have there described underlie the great majority of disorders of artificially-fed babies as we find them. The first thing we must do is to purify the intestinal canal of the infant, put it in a normal condition, and then we shall be in a position to feed it properly. I am thoroughly convinced that the great difficulties so commonly met in finding a suitable food for a baby, result principally from overlooking this factor.

Then another thing—when we have gotten the intestinal canal of the child in a normal condition, one which is aseptic so far as the food we wish to give is concerned, that is to say, so that it contains no germs which can make poisons out of the food we intend to give, then we must consider the food to be given to the child; it must be something adapted to the physiological conditions that are present. First, our selection of a food is to be guided by the pathological conditions present; next, it must be within the scope of the physiological possibilities of the healthy child. What are they? A healthy infant is not capable of digesting coarse vegetables, such as cabbage; it may take them into the intestinal canal, but they are apt to produce harm; it is not capable of digesting many fruits, particularly those that have a considerable bulk to them. Of the simpler foods, meat in particular is one which it is very rarely within

the power of the healthy infant to handle. Very frequently when we give scraped beef, beef tea, cooked beef, or expressed beef juice, or any other form of beef, to a baby, we find that the child develops more or less diarrhœa. There is no form of food which we give children which produces the intense putridity of stools as that which we notice following the use of meat or meat preparations. So I say, that almost absolutely meat is a food which is physiologically improper for a young child. We hesitate to give meat to a young puppy or kitten because we say it will give them fits. I don't know whether any such objection lies with regard to the use of meat with young babies, but this I do know, that in many instances it is the cause of derangement of the bowels of a child, and we must consider that, physiologically, it is not a suitable food. The foods which the infant can digest are principally cow's milk, eggs, sugar and starch. Under the head of starch we must put cracker, bread, rice, arrow root, baked potato, and oatmeal. Now, with these foods at our disposal for the proteids and carbohydrates, and with cream, bacon, and cod-liver oil for the fats, we have a complete list of what we can give an infant for food. The most easily digested fat is, apparently, cod-liver oil, next is cream, next butter, and next fried bacon. We all know how readily young children will digest fried bacon. It is a means of feeding which has grown up with the people; it is in quite common use. Beyond this list we would say that other foods, more complex, are unphysiological.

To summarize: The food must first be adapted to the conditions of the intestinal canal; it must not

contravene the physiological possibilities of the child. Having first by a proper dietary removed the pathological conditions, we are then to limit our food selection to the substances named, and which are within the physiological possibilities of the child.

The next condition which is relatively essential, is that the food given shall be sterile, which means that it shall be pure. Let me say pure instead of sterile because a great deal of the food given is pure enough but not sterile. All milk is contaminated with microörganisms in the act of milking and they are not taken out unless the milk is subjected to the actual process of sterilization, and as that is practically carried on, they are not taken out even then. But milk, even under such conditions, is a most excellent article of food and does a healthy child no harm; a healthy child, understand. But it is not sterile, although it contains no germs ordinarily which can make poisons out of the milk; it contains no germs which are pathogenetic, or which in themselves are detrimental to the child, therefore for the purpose of feeding it is pure. Let us say that the third requirement is that the food shall be pure. This brings us to the subject of sterilization. Sterilized milk is valuable simply because of its purity. The principal utility of sterilized milk lies in the fact that it does not introduce poisons into the intestinal canal of the child. When the child's bowels are once in a normal state, by sterilizing the milk we maintain them in normal condition, simply by a negative process.

Sterilization as applied to the preparation of infant food, consists in subjecting the milk to a temperature approaching that of boiling water, over a period

of from thirty to sixty minutes, and after having subjected it to this temperature, in preventing further contamination by keeping the air from it. This is the ordinary process involved in sterilizing milk, and it has been shown conclusively that this process does not destroy all life in the milk; it probably destroys all adult microörganisms, but the spores are not killed, and to actually sterilize milk in this manner, it would be necessary to repeat the process twice at intervals of twenty-four hours. But the milk which we feed to children and call sterilized milk, is not sterilized, it is only grossly purified. We must not delude ourselves with the idea that it is actually sterile. Furthermore it is highly improbable that such a thing is desirable. We know that the healthy intestines swarm with microörganisms, and if the milk is sterile when it enters, it is but a moment until it is far from sterile, but the organisms which grow in it under such conditions so far as known are of a harmless type, and it is quite immaterial how many such microörganisms are growing in the intestine at the time of its lodgment there.

We find not infrequently that children who have been fed upon foods most closely resembling human milk will not thrive, but when put upon sterilized milk they do thrive. Yet the latter may be a very gross imitation of human milk and very far from containing its several ingredients in the exact proportions found in human milk, while the other may be prepared carefully to have just so much casein, so much fat, so much carbohydrate, and so much water, and perhaps has been partially peptonized, so that when the casein coagulates, it coagulates in flakes and even looks like mother's milk in color.

Upon the one food the baby thrives, upon the other it dies, and the difference in results lies solely in the fact that sterilized milk is free from poison. But if we put sterilized milk into a poison-producing bowel, we might as well put in the poison itself, for sterilized milk can then be of no use.

The fourth condition which a food should meet is that it shall contain the necessary ingredients for complete nutrition. Now here is a most important problem to me; it is the prettiest point in the whole subject of infant feeding. What are the ingredients necessary to complete nutrition? Let us take for our guidance mother's milk. We know that healthy babies are raised upon mother's milk and we have every reason to believe that it is the best food which can be given to the child, because in the majority of instances children raised exclusively at the breast are the strongest and healthiest. Other things being equal, mother's milk is the type of food so far as this one feature of the problem is concerned.

What are the essential ingredients of a complete food for the child? We ought to be able to find our answer in an examination of mother's milk, and yet the method of examination applied has been found to be decidedly incomplete, and we have found that the chemical examination of mother's milk has not always told us what we are to look for. The analysis of mother's milk shows us that this substance is made up of fat, carbohydrates in the shape of milk sugar, proteids in the shape of casein and coagulable albumin, and salts and water. These several substances exist in quite constant proportions, and it is perfectly justifiable to assume that these proportions are the best for the nourishment of the child. Comparing

the analysis of milk with the dietary of the adult, it is shown that the infant requires these several classes of food in very different proportion from that found necessary for the adult. For instance, a baby does not require anything like as great a percentage of carbohydrates as the adult does; it requires about the same percentage of proteids, and a very much higher proportion of fat. A child a year and a half old requires about three-fourths as much fat in twenty-four hours as a full grown adult, to meet the requirements of its nutrition. This is a point we want to keep before us constantly. Growing bone needs fat to make its nutrition complete, and that is one reason why the baby requires so much actual fat to make up this condition. Now we not only require that these substances shall be present, but that they shall be present in the proper proportions, and these are the proportions found in mother's milk. But chemical analysis has not yet yielded us all the secrets of mother's milk, for there is at least one other element present, which we do not know chemically, and this is a substance which the English have called the anti-scorbutic element. What is it? In the days when sailors went on long sailing voyages and could not take with them animals to kill, or fresh fruit and vegetables, and consequently were deprived of these fresh substances for long periods, they developed the peculiar condition known as scurvy, or scorbutus. If, however, they were given in time fresh meat or vegetables, or were given fresh milk, they soon got over the scurvy. This as yet chemically unknown substance, the absence of which permits scurvy to develop, is found in fresh milk. The anti-scorbutic element, therefore, is to be regarded as one of the

important elements of an infant food, but not, as I shall show you later, one which is always essential. One of the most interesting cases of scurvy I ever saw was in Chicago, in a child whose food made it almost necessary that it should have scurvy. It was firmly held that everything that child should receive must be sterile, its milk was sterilized, the Imperial Granum mixed with water with which it was fed was sterilized, everything indeed that the child fed upon was sterilized, and in the process of sterilization this wonderful anti-scorbutic element was killed. The child was given plenty of food in every way except this anti-scorbutic element, and it developed an attack of scurvy and almost lost its life in consequence.

Remember that the mere chemical constituents of any food are but grossly the index to its food value. We cannot reach the full requirements of food-stuff by any chemical examination, nor by any means, except actual trial tell whether or not a given food is sufficient for a given organism.

If the mother has scurvy, her offspring will have scurvy; if she is cured, her child nursing at the breast is also cured. A female, then, who contains the anti-scorbutic element, can transmit it to her milk, and this is done by the healthy human being and by the healthy cow, so a healthy milk will contain the anti-scorbutic element, and furthermore, raw milk contains it, while it is destroyed in the process of sterilization, in the process of condensing, in the process of drying, so that every food we have which contains sterilized milk, or condensed milk, or dried milk, is necessarily deficient in the anti-scorbutic element.

A great many of the so-called infant foods in the market are deficient in one or another ingredient,

and I should hesitate to say that any of the foods containing the dried milk solids are sufficiently rich in fat or proteids. You can give any quantity of proteids in the way of dried milk and some babies will digest them, while they will pass through others. The dried milk solids fail to answer that physiological necessity which I called the second requirement of an infant food; they cannot be assimilated by the individual in question, although you may be giving plenty of proteid, chemically speaking. The great majority of prepared foods are deficient in fats. What is the result? A food deficient in fat produces rickets; a food deficient in proteids produces rickets; and any food that is rich in carbohydrates, simply because it is therefore relatively deficient in fats and proteids, produces rickets. If we use wheat so as to make it the basis of food, we are giving more carbohydrates than mother's milk can possibly contain; if we make oatmeal the basis of food—and I have seen babies raised on simply oatmeal mush and cream, not another article of food being given them—we are giving the child a deficiency, I won't say of fat, because the cream will in all probability make up for the fat, but a deficiency of proteids; there is not enough material to make tissue, and what is made is necessarily a degenerate, unphysiological tissue. They used to tell us that a person who drank beer was pussy and bloated, and did not have good fat, but it always appeared to me that fat was fat, and whether the individual got his fat from drinking beer or eating sugar, it was all the same. But this assumption is certainly incorrect. An individual who gets his fat in one way is different from one who gets it in another way; there is a

healthy fat and an unhealthy fat. You take a fat baby, and that baby may be thoroughly rachitic; it may be suffering from fat starvation. The negroes in the South on the sugar plantations ate largely of sugar, sucked the sugar cane, and became decidedly roly-poly; they abounded in fat; fat formed in every part of their anatomy where it could form, and yet they were thoroughly rachitic. We can give a baby a prepared carbohydrate food, or we can give it an excess of arrow root, an excess of oatmeal, an excess of bread, or crackers, or starch of any kind, and that baby will get fat, because we know it is a rule that carbohydrates, sugar and starch, if they be in excess, are transformed into fat, and furthermore we know that if an excess of proteid material be given to an individual, it is transformed into fat. This is true of children and adults as well. But fat so made is not valuable for the nutrition of the growing child; I cannot explain to you why, but the statement is unquestionably true. The child, then, needs fat as such; it must receive the fat in the shape of fat, or it is of no use to it. The fat which forms on its body cannot be utilized by it in the same way as fat received by it in the shape of cream or butter, or cod-liver oil; that is the reason we take a fat baby with rickets and give it cod-liver oil, cream, or any other fat the peculiar circumstances may dictate to us. The fat laid up on the baby is not fat which that baby can use for the purpose of making bone-tissue, but the fat which it takes, in the shape of cod-liver oil, the food which is fat at the time it is taken, it can use in the manufacture of bone-tissue, it can use in the development of that nutrition which is necessary to prevent rickets. What is rickets?

Rickets is a disease of innutrition, therefore it is properly considered by us when speaking of infant feeding. It is the result of a vicious process of feeding, a process which does not supply a complete nutrition; it follows the use of foods which do not contain, in their proper proportion, all of the ingredients that I have mentioned to you. Rickets may be defined as a form of innutrition characterized by certain neuroses, viz.: sweating, particularly about the head, restlessness at night, and convulsive manifestations, particularly laryngismus stridulus, and general convulsions; by delayed dentition, and finally by the occurrence of certain bony deformities.

The bone changes are late, and we don't want to wait to make a diagnosis of rickets until after the bone changes have come on; we don't want to make a diagnosis of a cyclone after the houses are all torn down. And so it is with rickets; anybody can make a diagnosis of rickets after it has swept over the baby and left him with bandy legs and big head, but we want to make the diagnosis of rickets before the bone changes are apparent. Rickets is a disease not so much of malnutrition as of innutrition, it is a disease which arises because the complete nutrition which the child needs has not been given to it; usually it is a case of fat starvation, but it may be a case of proteid starvation. Rickets, then, is a starvation disease, and the rational treatment of rickets is to supply the proteid, to supply the fat which has been lacking in a given case. Scurvy is likewise a disease of innutrition, but for it to be produced there must specially be withheld from the child that single mysterious, unknown anti-scorbutic element which is present in fresh meat, which is present in fresh milk and fresh vegetables.

We don't know what this element is, but it exists, and we know how to keep it away and how to supply it. If we keep this element away we are liable to get scurvy, and scurvy in its early stage is indistinguishable from rickets. The babies sweat, they have pain in the limbs resembling rheumatism, and in some instances an area of hyperæsthesia which is said to be characteristic of rickets, but which I believe is never characteristic of rickets, but always of scurvy. The acute rickets of the Germans is probably the scurvy of the English. I remember a case, which was called rheumatism, in a baby about eight months of age, and as I look back on that case now I am satisfied that it was scurvy. I believe that scurvy is classed not infrequently as cerebro-spinal meningitis because of the hyperæsthesia present. If we make a diagnosis of cerebro-spinal meningitis simply because hyperæsthesia is present we are careless. Let us rather go back and see what the nutrition has been, and whether it has been such as might possibly lead to scorbutic disease.

A child's nutrition may fail because of failure at one or more of several points. In the first place, the food may be deficient in quality or quantity; in the next place, the digestion may be disordered, so that the child cannot thoroughly digest the food, which, of course, then cannot be absorbed; or the failure may come from diminished absorptive power. Again, the bulk of the food which goes through the portal vein and liver may fail to find in the elaborative organs the necessary change which it should find there to fit it for assimilation by the cells; or, having gotten the food into circulation and ready for assimilation, individual cells may not be able to take

it up. The starving cell, when the food is right alongside of it, may not be able to utilize it; and why? Because, with continuous starvation, its chemical constitution has been so modified that it is no longer able to directly unite with the food brought to it. This is possible, no doubt is common, in certain cases of disease, for instance, in influenza, in which it seems to play a great rôle. Another factor is deficient cell power because of heredity. The individual inherits an abnormal cell which is incapable of maintaining its own nutrition, even in the presence of an abundant food supply. This sort of heredity is common to the syphilitic baby, the tuberculous baby, and possibly to the rheumatic child, and the child whose parents have Bright's disease; but certainly it is true of the syphilitic and tuberculous child, that the tissues themselves are unable to assimilate the food which has been brought to them in a proper condition. Fortunately, in the case of the syphilitic child, we can so modify the structure of the cells by means of mercury, that they can again assimilate. This explains why a syphilitic baby, in a state of marasmus more or less marked, does not get well upon mercury alone. It may improve for a while, but presently it stops improving; but when you add to that mercury a proper dietary, it picks up immediately. In the first place, the mercury will put the individual cells in such a condition that they can use the food brought to them; but if the food is not brought to them, all the mercury in the world can't cure the child. Furthermore, if we simply try to relieve the baby by giving the proper food while the cells are unable to assimilate the food brought to them, no matter how carefully prepared it may be or

how thoroughly well it may be absorbed and elaborated, if that cell is still syphilitic, it cannot properly assimilate it, and the child goes on to a peculiar form of starvation. Now, when we put our mercury in, we modify that cell, assimilation goes on, and the child improves; so two factors become necessary in the cure of the syphilitic baby. In the case of the tuberculous baby we have no such means at our disposal for cell improvement; we have no specific which will compel the cells to take up the nutrition brought to them, and it is only by indirect ways that we are able to improve the nutrition of the tuberculous individual.

I have shown you the necessity of a complete food containing a large quantity of fat and of proteid material, and the necessity for purity. Now, with these general principles, let us consider how we would feed a new-born baby that we had to feed artificially. If we know from the start that the child will not have the benefit of mother's milk, what shall we do? Shall we proceed without delay to feed that child? I am satisfied that during the first three days, during which the mother's milk is not secreted, and during which we normally allow the child to go unfed, a certain lack of strength ensues to the baby, and while I am perforce compelled to withhold food from the baby that is to be fed at its mother's breast until the mother's milk comes, so that the intestinal canal of the child may not be contaminated with improper germs, yet if I know at the beginning that I must feed that baby with artificial food, I proceed at once to do it. How? Always at first with sterilized milk. I should take cow's milk, and, because it is not so dilute as mother's milk, I would add to it a considerable quantity of water; I would add an equal bulk of water,

thus supplying the child not only with milk and food, but with drink. The very important element of water is not to be overlooked; water is not only a food, but it is likewise an eliminant generally, and you will find that if you deprive a new-born baby of water, it will cry. I have found this cry to be not always one of thirst, but sometimes of pain. I have in several instances, taken care to keep everything, even water, from a new-born baby. It would, after some hours, begin to cry, and on giving it water, in an hour or two the crying would cease, and shortly after it would pass urine, and I have found in these cases uric acid crystals on the diaper of the child. In all probability, these babies had uric-acid infarction of the kidneys, and because they could not get water, had no means of flushing out the tubules of the kidneys, and the passage of these uric-acid crystals through the kidneys was what caused the pain. Two hours after drinking water they would stop crying, and we would find these crystals. Now then I would take about half water and half milk, not because mother's milk shows there shall be so much water, but to be sure that the baby shall get enough water; then I should add a small quantity of cane-sugar to it, and put into each bottle one ounce of such a mixture, sterilize and feed every two hours. It is my custom to feed a baby at six o'clock in the morning, at eight, at ten, at twelve, and every two hours up to ten o'clock at night, and then I stop, letting the baby cry if it wants to, all night until six o'clock the next morning, and then go on feeding it every two hours until ten o'clock at night, when I stop feeding it. When the time for feeding the baby comes around I have it awakened if it is asleep. At six o'clock I

would deliberately waken the child and put it to the breast or the bottle, and try my best to make it take food. We know that the food which the child will get in this way is quite sufficient for its strength. A new-born baby may have a tendency to sleep during the day and be awake at night, but inasmuch as a baby is absolutely without habit when born, and may be made to assume any habit you choose to impose upon it, you should be careful to train it to good habits only, particularly impressing the habit of sleeping at night and being awake in the daytime. It is a little hard to get mothers to follow such directions, but if done the baby can be trained nine times out of ten, and the tenth time it fails. Of course, babies are not machines, and that ten per cent. serves to separate humanity from pure mechanism. In a few days the baby will acquire the habit of waking every two hours, and it will know when ten o'clock at night comes, and will sleep all night. It is exceedingly common for mothers to break the rule and feed their babies once or twice during the night, but where I have intelligent people to deal with, I find that they can make the baby sleep all night, and it will be perfectly healthy. The great danger of too frequent feeding is prevented by this plan, and the child's stomach has the rest which it actually requires; this is true both of babies artificially fed, and of babies fed at the breast. It is a very nice thing for a mother to know that she can leave her baby at eight o'clock in the morning, go down town and get back at ten o'clock, and know that during that time the child will not need her. If she happens to stay too long, her breasts will fill up; they act with regularity just as the child does. I

feel that I ought to speak very strongly upon this point, because you can carry it out if you will take the trouble.

Much has been written upon the manner of gauging the quantity of food which a baby should receive. Two general systems are in vogue, one in which the quantity is regulated by the age of the child, and the other, more rational, in which the quantity is determined by the weight of the child. Personally I take a different ground, and think that I meet the requirements very well. I am in the habit of allowing a baby who has been properly trained to be its own judge of what it shall receive. I cannot let a baby who has been improperly trained be the judge of what it shall receive, but when I have gotten a baby into proper habits of feeding the best I can do is to be guided by its own demands. For instance, let me refer to a baby which has been under my care for about five months, a typical artificially-fed baby. It was fed upon what was called sterilized milk before it came into my hands, and the milk was so sterilized that it was no wonder the baby was subject to considerable diarrhœa. After curing the diarrhœa and getting the bowels into normal condition, it was put upon sterilized milk every two hours. It is now receiving its milk every three hours and as regularly as the clock strikes the baby gets its bottle. Up to the present the quantity was forty ounces of milk and twenty ounces of water put into eight bottles, that is seven and a half ounces to each bottle. For a period of two months it has received that quantity, but for the last few days it has cried after each bottle. My direction is if the child cries after it is fed a bottle of milk, pay no attention to it, it may be something

accidental, but if it cries after every bottle it gets, for two or three days, the stools being normal, and the cry not one of pain but dissatisfaction, you may then be satisfied that it is the cry of hunger and not that of pain or anger. A properly-fed baby does not get out of temper, it does not cry like a baby fed hit or miss, but you can depend upon its statement that it is hungry. I am far enough from taking the statement of the mother that every time the child cries it is hungry, because that is the sole interpretation of the mother. But having found a baby that is properly fed, and who cries frequently and steadily after each bottle, I don't care whether the child has been receiving the exact quantity for that age, as laid down in the books, or a greater quantity, it is not the proper quantity for that particular child. Now what do I do? This having occurred in the case under discussion, I to-day increased the quantity of milk and decreased the quantity of water. Perhaps I was not wise in this particular instance—time will show—but I made up for the decrease in water by directing that the child should be given water between meals. The quantity of water that the child was getting represented a much more dilute mixture than mother's milk. We cannot measure the water exactly that we give a child, but if we give the relative proportion of solids and plenty of water, whether the water is given with the food or not, we have done our part. I told the mother, in this case, to increase the milk from forty to forty-five ounces, and to decrease the water from twenty to fifteen ounces, and to give the same quantity; instead of two-thirds milk and one-third water, it would be three-fourths milk and one-fourth water. A child, even on

so small a quantity as five extra ounces of milk a day, will be satisfied, and so long as it is satisfied, be sure you let well enough alone. I feed this baby on sterilized milk, and nothing else. It is the food upon which I put all healthy babies at first. I told you sterilized milk was deficient in the anti-scorbutic element, so that it looks as if I were a trifle careless; but that is not so. I would be careless if I ignored that fact; I would be wrong if I did not know that fact; but when I know that the milk is deficient in the anti-scorbutic element, when I know that it does not form a complete nutrient for the child and I watch the result carefully and change with the first signs of trouble, then I am doing my full duty.

Certain observations made by Davis, of Philadelphia, go to show that sterilized milk is always an incomplete nutrient for children; that children fed upon sterilized milk invariably present certain symptoms of innutrition. I do not think this is invariably true, but I am willing to admit that every baby fed exclusively upon sterilized milk is liable to show some form of innutrition, either as a distinct form of scorbutus or one or another of the starvation neuroses. But many children do not. The majority of children, in my experience, do well on sterilized milk and the danger from its use is certainly not as great as Davis asserts. So it seems that many children may do well, for a long time, without the anti-scorbutic element. Now if this child goes along nicely, does not sweat about the head, is not restless at night, does not develop scurvy, does not develop painful muscles and joints, gets its teeth in regular order, has the fontanelles of the head close up at the eighteenth or nineteenth month of life, is

not pallid but has a nice rosy color of the skin, and in general shows that its nutrition is perfect, I shall let the sterilized milk go on. But if the mother should come to me and say that the child's color is not just what she wants, and that for the last four or five days she has noticed that the child is not so active as formerly, doesn't seem to feel so well, doesn't take his food with a relish, then I should investigate and try to find out to what these symptoms were due. A mother will often notice a slight change which you could not possibly see. If she should call my attention to these things, I should watch and endeavor to find out whether the change was due to some pathological process, some infective disease coming on, or to innutrition, and when I had satisfied myself that it was due to innutrition I would stop sterilizing the milk and give the child raw milk. In other words, I should take away the safeguard that I have in sterilization, as to bowel disorders, for the sake of preventing the child's nutrition positively failing. I want to say here that we can tell within two weeks when a child begins to fail on sterilized milk, and in two weeks more, by simply putting it on raw milk we can bring it back to a normal condition. I have done this. If we keep our eyes open, while we tread on dangerous ground in using sterilized milk, we are perfectly safe. When we put the child on raw milk we run the risk of setting up disease of the intestinal tract, but by its use we certainly avoid a positive danger in preventing certain forms of innutrition.

In conclusion permit me to summarize:

1. In instituting artificial feeding, the alimentary canal of the infant should first be put into normal

condition, and during this period the food should be such as is adapted to the conditions in the alimentary canal, irrespective of its properties or value as a complete nutrient.

2. The food used should be within the physiological capabilities of the baby.

3. The food adopted should be pure, and if the conditions will permit, it should be sterilized.

4. The food intended for the complete nourishment of the infant, should contain the necessary quantities of proteids, carbohydrates, fats, and salts, and the composition of human milk should be used as the guide in determining these factors.

5. The anti-scorbutic element should usually be present. In its absence the child should he carefully watched, and this element supplied when found necessary.

6. Sterilized milk, and foods made up of dried milk solids, are deficient in the anti-scorbutic element.

7. Water is an essential ingredient of the food supply of the infant, and should be administered freely.

8. Foods which are deficient in one or more of the necessary ingredients, lead to the development of various forms of innutrition, particularly rickets and scurvy.

9. The infant should be fed at regular intervals, and not overfed.

10. The best artificial food for a healthy infant is pure milk, from healthy cows, properly diluted, and sweetened, and sterilized if the conditions of nutrition permit.

CHAPTER V.

STARVATION NEUROSES.

Among the most important of the functions of of the pediatrician is the study of the diseases incident to development.

All diseases of infancy and childhood reflect, on the one hand, effects resulting from the initiatory immaturity of the various tissues and organs, and on the other hand, effects resulting from perversions of the complex processes of growth.

The physician must accept as inevitable, the normal immaturity at birth, and confine his attention to the processes of growth. At least, I shall not attempt to consider here what influence he may be able to exercise toward modifying this condition of immaturity at birth by previous attention to intra-uterine processes.

After birth, aside from accidental and extraneous causes of disease, the development of the individual is influenced by two factors, heredity and nutrition. Some of the auto-intoxications cannot be classed, with propriety, as either accidental or extraneous causes of disease, and so perhaps should be considered as a third factor influencing development.

The hereditary potentialities acquired during intra-uterine life must ever remain with the individual; they cannot be eradicated, but only increased

or diminished, to a greater or less degree, by environment.

There remains, then, the matter of nutrition as the most profitable feature for the pediatrician to study in connection with the processes of development.

It is, perhaps, supererogation to attempt to show that "the meat makes the man," but I beg to recall to you the old German proverb, "Der Mensch ist was er iszt," to show that the idea that the individual is strongly influenced by the kind and quality of the food which he eats, is deeply rooted in general belief, and therefore probably contains at least a grain of truth.

It may not be improper to refer to the words of Cassius:

> "Now in the names of all the gods at once,
> Upon what meat doth this our Cæsar feed,
> That he is grown so great?"

Owing to the peculiar circumstances of its growth, the Turkish tobacco is the best in the world; the celery of Kalamazoo is unequaled for the excellence of its flavor; the tea plant cannot draw its delicate flavors from the soil of our own country. To advance to instances in animal life: the canvas-back duck does not possess the qualities which tickle the palate of the connoisseur until after it has fed upon the celery along the shores of the Chesapeake Bay. We can hardly conceive of a palate so crude that it cannot distinguish between the flesh of the corn-fed and of the slop-fed hog, yet the histologist does not exist who can distinguish between the tissues of these animals, and the chemists are as yet unable to tell us the secret of the difference between them.

If such slight differences in food supply can produce such striking results, what results may we not expect to find when the necessities of complete nutrition, as determined by our present, relatively crude, methods of chemical analysis, are grossly violated? It is surprising to see how often the food supply of infants is markedly deficient in one or the other of the fundamental kinds of food material. But it certainly is not surprising, when such deficiencies do occur, that numerous evidences of the resulting innutrition are noticed.

A house is to be built of stone, and wood, and metal. If these terms are translated to mean granite, oak, and steel, a noble structure will be made; but if they are taken to mean soapstone, pine, and zinc, a very sorry work will follow. If one element is left out entirely, or supplied in niggardly quantity, the result must necessarily be even more defective.

The child is to be built up on proteids, carbohydrates, and fats. If, now, these substances, as found in healthy human milk, be taken for this purpose, the best possible result will be attained; but if substitutes for them must be used, then the result will be bad, in proportion to the deviation from the normal, and if one or the other of these several classes be entirely omitted, or supplied in insufficient quantity, the result is the worst that can be had.

Many of the evidences of innutrition produced by deficiencies in food supply, are manifested as neuroses.

Clouston, in his recent very valuable work on "The Neuroses of Development," has pointed out, in a masterly way, the influence of heredity in the production of such neuroses, but so far as I can find

from an examination of his work, he has not laid stress upon the influence of incomplete food supplies upon the development of the several organs and tissues, and their consequent influence upon the development of neuroses.

Rickets is a disease of incomplete nutrition, and, as Cheadle* has already pointed out, is produced by continuous deficiency in the supply of either proteids or fats. The influence of other factors, such as heredity, congenital syphilis, the indefinite bad hygienic surroundings, is ably discussed by Cheadle, and they are shown not to be constant factors. We are not concerned at present with a discussion of the general etiology of rickets, and I may dismiss this part of the subject with the statement that I thoroughly believe that the most important, and perhaps the only necessary factor in the causation of rickets is a long-continued deficiency of proteids, or fats, or both, in the food supply. I am unable to speak positively, however, of the part played by a deficiency of the supply of fresh air, which must certainly be regarded, in some respects at least, as a food.

The earliest manifestation of rickets is sweating, particularly about the head, and more particularly about the back of the head. Restlessness at night soon makes its appearance, and with it a disinclination to remain covered. Often before any bony changes become apparent, various convulsive manifestations appear, especially laryngismus stridulus and general convulsions. When the disease is well established, its ravages are seen to be widespread. Not only are the well-known bone changes present, but the muscles are flabby, the ligaments relaxed,

* Artificial Feeding and Food Disorders of Infants. London, 1889.

and lymphatics, liver, and spleen frequently enlarged. There is anæmia, and dentition is delayed, and hydrocephalus is not infrequently present. Certain lung changes, usually mechanically secondary to the chest deformities, are often seen, and there is a marked tendency to so-called catarrhs of mucous membranes, especially bronchitis and diarrhœa.

Some of these symptoms are evidently neuroses, and it is with them that we are at present concerned.

The possible neuroses to which the organism is liable, may be roughly classified as follows:

Neuroses relating to:

A. Psychic faculties.

B. Sensation.
   1. Anesthesia.
   2. Hyperesthesia.
   3. Neuralgia.

C. Heat production.
   1. Elevation of temperature.
   2. Depression of temperature.

D. Muscular tissues.
   I. Hypertrophy.
   II. Atrophy.
   III. Paralysis.
   IV. Convulsions.
      1. Skeletal muscles.
         a. General convulsions.
         b. Chorea.
         c. Tetany.
      2. Pharynx.
         a. Dyspnœa.
         b. Dysphagia.
      3. Œsophagus.
         a. Dysphagia.

4. Stomach.
   a. Vomiting.
   b. Merycism.
5. Intestines.
   a. Increased peristalsis.
   b. Decreased peristalsis.
6. Larynx.
   a. Dyspnœa.
   b. Laryngismus stridulus.
   c. Chorea.
7. Bronchi.
   a. Asthma.
8. Bladder.
   a. Incontinence.
   b. Retention.
9. Urethra.
   a. Spasmodic stricture.
10. Uterus.
11. Vagina.
   a. Vaginismus.
12. Heart.
   a. Chorea.
   b. Disturbance of rate.
   c. Disturbance of rhythm.

E. Secretory organs.
   1. Increase of secretion.
   2. Decrease of secretion.
   3. Modification of composition of secretion.

F. Absorptive organs.
G. Elaborative organs.
H. Respiratory organs.
I. Excretory organs.
J. Reproductive organs.

Of these various possible neuroses, some, such as those of the elaborative organs, cannot be shown to exist at all in the present state of our physiological knowledge; others again, as those of the genital organs, do not exist in childhood; while still others do occur, some occasionally, some very frequently.

Of the psychic neuroses, perhaps the commonest is pavus nocturnus, night terrors. No doubt heredity is a potent factor in its production, but it occurs in illy-nourished children with great frequency. Hyperesthesia is shown to be a starvation neurosis by its occurrence in scurvy.

It is difficult, if not impossible, to show that variations of temperature are, at any time, simple neuroses, but I have noticed sub-normal temperature in children suffering from evident innutrition.

Of all the starvation neuroses, the commonest are muscular convulsions. Naturally enough any muscle, or any group of muscles, may be affected, and the manifestations may present all the varieties of convulsive movements to which muscles are liable.

Probably no child, whose nutrition is perfect, ever has general convulsions, except as the result of actual brain disease, or at the onset of some infectious process, where the convulsion takes the place of the initial chill of the adult.

So far as I am aware, the so-called reflex convulsions occur only in children whose nutrition is below par. In a rachitic child, the slight irritation produced by a prorupting tooth may be sufficient to set in motion the mechanism which causes convulsions, just as in the same child it may be the determining cause of bronchitis. In the perfectly healthy child dentition can cause no such effects. Both these

manifestations, the convulsions and the bronchitis, are consequently to be classed as starvation neuroses. In such children, many other trivial conditions may start the convulsive mechanism.

I have had one case in which tetany occurred in a rachitic baby a little over one year old. There was, however, an obscure acute fever going on at the time, other marked nervous symptoms were present, and the bowels were disordered, so that it was impossible to determine the particular factors which produced the tetany.

In older children, chorea, whatever be its cause, is evidently connected with the developmental processes. Notwithstanding all the work which has been done upon the subject, the etiology of chorea still remains obscure. We have all noticed the beneficial effects in chorea of absolute rest in bed, and forced feeding. The possibility of its being a starvation neurosis should always be borne in mind, and observations of choreics with reference to this feature are very desirable.

Dysphagia as a neurosis in children, is certainly uncommon, but I have at present under my care a rachitic infant who presents this symptom.

Vomiting and diarrhœa occur so frequently in infants, from a wide variety of causes, that it is very difficult to say when they are merely starvation neuroses. But in rickets diarrhœa often occurs, for which no adequate explanation can be found in the conditions present in the intestinal canal, and which appears to be an essential feature of the disease itself. Such diarrhœa recovers under the use of cod-liver oil, and it is probably not going too far to designate it as a starvation neurosis.

The connection of laryngismus stridulus with rickets has been shown time and again. It is a very common manifestation of this disease, and probably the most common of all the muscular starvation neuroses. Even in older children, affected with pharyngeal adenoids, and in whom laryngismus stridulus frequently occurs, there can usually be found some nutritional defect.

I have once seen spasmodic asthma occur in a rachitic child.

The following case will illustrate another starvation neurosis:

Harry S., age seven months, ever since birth has cried before passing his urine. The bladder is evacuated about once an hour, and there is always tenesmus. Alkalies produced no change in the conditions, but slight relief followed the use of potassium bromide. He was then put upon cod-liver oil, and in two weeks the urinary symptoms had entirely disappeared. Other symptoms of rickets were present, including absence of teeth, profuse sweating about the head at night, and night terrors.

Is incontinence of urine in older children a starvation neurosis? Certainly no one can be wholly satisfied with the views of the pathogenesis of this affection now extant. They are evidently incomplete. And certainly no one can be satisfied with the results of the treatment now employed in this affection.

Let me call your attention to a case which shows at least, that incontinence of urine may be associated with incomplete nutrition:

Harry E., age four and one-half years, has always had incontinence of urine, which for the first two and one-half years was both nocturnal and diurnal, but for the past two years the incontinence has been diurnal only, except that he wets the

bed probably once a month. His anal control is not perfect, although no actual incontinence occurs, but when it becomes necessary to evacuate the bowels he is compelled to hurry to avoid an accident. He is small and light in weight; the mucous membranes are pale; the teeth are sharp, but not notched; the palate is rather high. Bowels are regular but inclined to constipation. When a baby, the syringe had to be used constantly to secure a passage. Movements very dark, odor very putrid. The stool is large and moulded, and is followed by softer fæces. Appetite not good. Drinks a great deal of water. Sleeps well; is quiet, does not snore. No eye, ear or nose trouble. No headaches. No profuse sweating. Weighed six pounds at birth. First tooth appeared at nine months. Had much trouble during second summer with diarrhœa. There is no history of head sweating during infancy, but he was then restless at night, and disliked to be covered.

Was nursed at the breast for seven months, and was then put on condensed milk and one cow's milk, receiving also mashed potatoes and oatmeal, which latter material formed a large part of his diet. He was early taught a habit of chewing beef, swallowing the juice, and rejecting the pulp. This habit he still has, and consequently gets very little meat. Fat, also, practically finds no place in his dietary. His principal food at present is potato, in addition to which he eats bread and crackers in small quantities, and vegetables and fruits. Apples and bananas he is very fond of, and eats them in large quantities.

The analysis of such a case, no doubt, is difficult, many factors being involved, but certain features of the case stand out prominently: He is badly nourished, and his food, for at least four years, has been markedly deficient in proteids and fats. Can we associate his incontinence with these features? To bring this boy's degenerate tissues into a normal condition will require months of proper feeding, if indeed, the abnormal tendencies with which they have been impressed already can ever be wholly eradicated. The lesson to be drawn from such a case

is the necessity of providing infants and young children with a diet which contains all the necessary elements for complete nutrition.

The younger the child, the more rapid are its processes of growth. Hence in infants the results of defective nutrition are quickly manifested, and the curative effects of food arranged to supply the nutritive deficiencies also become apparent very soon. In older children, with more stable tissues, a defective food supply is longer borne without apparent effect, and on the other hand the beneficial effects of an antidotal diet become apparent only after a prolonged use.

The relatively simple diet of the infant makes it easy to discover the particular kind of food which is supplied in insufficient quantity, and makes the supply of the deficiency comparatively easy. But in older children, with a more varied diet, the defect is less readily discovered, and less readily supplied.

I have frequently throughout this paper used the term rickets, although not from choice, but from necessity. The term rickets, as at present employed, covers the results of a wide range of nutritional perversions, and I have no doubt but that, as our knowledge of these subjects becomes more accurate, we shall be able to separate several nutritional disorders from the group now covered by the name rickets. In another direction, the term rickets is defective, inasmuch as it does not cover the nutritional defects found in older children, and for which no better term now exists than malnutrition, or innutrition.

It has not been my purpose in this paper to ignore or belittle the influence of heredity and of autointoxication in the production of perversions of

growth, but rather to direct attention to the effects produced by deficient food supply, and particularly to some of the neuroses incident thereto, and for which neurotic manifestations I believe the term "starvation neuroses" to be peculiarly applicable.